US012070214B2

(12) **United States Patent**
Walberg et al.

(10) **Patent No.: US 12,070,214 B2**
(45) **Date of Patent: *Aug. 27, 2024**

(54) **CLIP APPLIER AND METHODS OF USE**

(71) Applicant: **Abbott Laboratories**, Abbott Park, IL (US)

(72) Inventors: **Erik K. Walberg**, San Jose, CA (US); **Timothy C. Reynolds**, Sunnyvale, CA (US); **Brian A. Ellingwood**, Sunnyvale, CA (US); **Kai Yenkai Jair**, Cupertino, CA (US); **Anthony J. Pantages**, San Jose, CA (US)

(73) Assignee: **Abbott Laboratories**, Abbott Park, IL (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 93 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **17/827,872**

(22) Filed: **May 30, 2022**

(65) **Prior Publication Data**

US 2022/0330942 A1 Oct. 20, 2022

Related U.S. Application Data

(63) Continuation of application No. 16/144,195, filed on Sep. 27, 2018, now Pat. No. 11,344,304, which is a (Continued)

(51) **Int. Cl.**
A61B 17/10 (2006.01)
A61B 17/00 (2006.01)
(Continued)

(52) **U.S. Cl.**
CPC ***A61B 17/10*** (2013.01); ***A61B 17/0057*** (2013.01); ***A61B 17/064*** (2013.01);
(Continued)

(58) **Field of Classification Search**
CPC A61B 17/0057; A61B 17/1227; A61B 17/068; A61B 17/08; A61B 17/083;
(Continued)

(56) **References Cited**

U.S. PATENT DOCUMENTS

287,046 A 10/1883 Norton.
438,400 A 10/1890 Brennen.
(Continued)

FOREIGN PATENT DOCUMENTS

AU 2003297432 A1 7/2004
CA 233960 A 9/1923
(Continued)

OTHER PUBLICATIONS

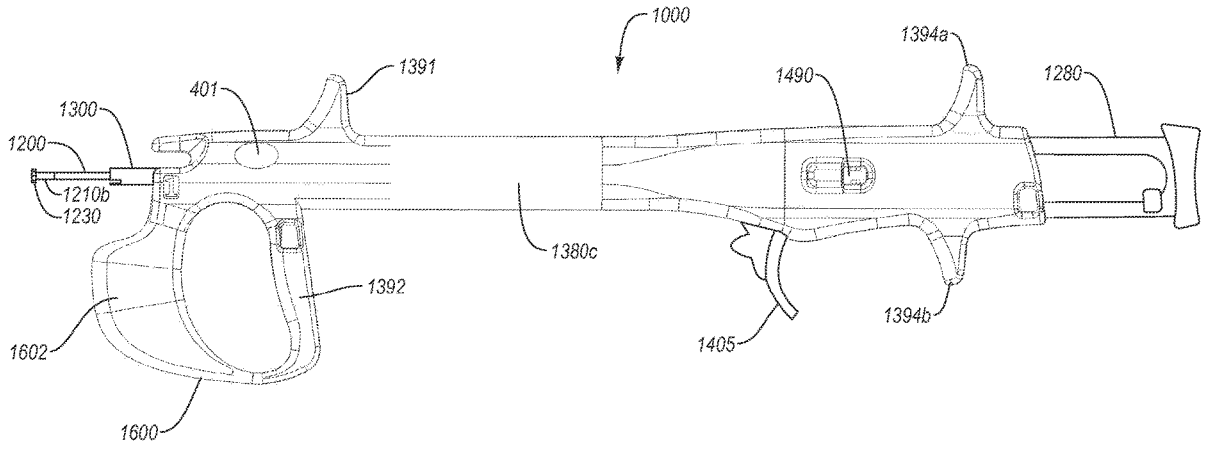
Notice of Allowance received for U.S. Appl. No. 09/764,813, mailed on Jun. 4, 2001.
(Continued)

Primary Examiner — Darwin P Erezo
Assistant Examiner — Christina C Lauer
(74) *Attorney, Agent, or Firm* — Workman Nydegger; Randy Shen

(57) **ABSTRACT**

A device for closing a tissue opening includes a proximal housing portion having a first portion, a second portion, a third portion, and a fourth portion. The first portion and the fourth portion extending transversely to a longitudinal axis of the proximal housing portion on opposite sides of the proximal housing portion. A distal portion extends from the proximal housing portion. At least the second portion and the third portion are configured to move toward the first portion.

20 Claims, 26 Drawing Sheets



Related U.S. Application Data

continuation of application No. 14/732,977, filed on Jun. 8, 2015, now Pat. No. 10,085,753, which is a continuation of application No. 13/898,202, filed on May 20, 2013, now Pat. No. 9,050,068, which is a continuation of application No. 13/615,547, filed on Sep. 13, 2012, now Pat. No. 8,518,057, which is a continuation of application No. 11/427,297, filed on Jun. 28, 2006, now Pat. No. 8,313,497.

(60) Provisional application No. 60/696,069, filed on Jul. 1, 2005.

(51) **Int. Cl.**

A61B 17/064	(2006.01)
A61B 17/068	(2006.01)
A61B 17/08	(2006.01)
A61B 17/122	(2006.01)

(52) **U.S. Cl.**

CPC .. ***A61B 17/068*** (2013.01); *A61B 2017/00424* (2013.01); *A61B 2017/00672* (2013.01); *A61B 17/0644* (2013.01); *A61B 17/083* (2013.01); *A61B 17/1227* (2013.01)

(58) **Field of Classification Search**

CPC A61B 17/10; A61B 17/128; A61B 2017/1107; A61B 17/0064; A61B 2017/00575; A61B 2017/00584

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

556,082	A	3/1896	Boeddinghaus
1,088,393	A	2/1914	Backus
1,123,290	A	1/1915	Von Herff
1,242,139	A	10/1917	Callahan
1,331,401	A	2/1920	Summers
1,426,111	A	8/1922	Sacker
1,480,935	A	1/1924	Gleason
1,516,990	A	11/1924	Silverman
1,596,004	A	8/1926	De Bengoa
1,647,958	A	11/1927	Ciarlante
1,847,347	A	3/1932	Maisto
1,852,098	A	4/1932	Anderson
1,880,569	A	10/1932	Weis
2,075,508	A	3/1937	Davidson
2,087,074	A	7/1937	Tucker
2,108,206	A	2/1938	Mecker
2,210,061	A	8/1940	Caminez
2,254,620	A	9/1941	Miller
2,316,297	A	4/1943	Southerland et al.
2,371,978	A	3/1945	Perham
2,453,227	A	11/1948	Janes
2,583,625	A	1/1952	Bergan
2,610,631	A	9/1952	Calicchio
2,684,070	A	7/1954	Kelsey
2,755,699	A	7/1956	Forster
2,756,748	A	7/1956	Ferguson
2,910,067	A	10/1959	White
2,944,311	A	7/1960	Schneckenberger
2,951,482	A	9/1960	Sullivan
2,969,887	A	1/1961	Darmstadt et al.
3,014,483	A	12/1961	McCarthy
3,015,403	A	1/1962	Fuller
3,029,754	A	4/1962	Doyle
3,113,379	A	12/1963	Frank
3,120,230	A	2/1964	Skold
3,142,878	A	8/1964	Santora
3,209,754	A	10/1965	Brown
3,209,784	A	10/1965	Schwartz
3,348,595	A	10/1967	Stevens, Jr.
3,357,070	A	12/1967	Soloan
3,482,428	A	12/1969	Kapitanov et al.
3,494,533	A	2/1970	Green et al.
3,494,553	A	2/1970	Nelson
3,495,586	A	2/1970	Regenbogen
3,510,923	A	5/1970	Blake
3,513,848	A	5/1970	Winston et al.
3,517,128	A	6/1970	Hines
3,523,351	A	8/1970	Filia
3,525,340	A	8/1970	Gilbert
3,557,794	A	1/1971	Van Patten
3,586,002	A	6/1971	Wood
3,604,425	A	9/1971	Le Roy
3,618,447	A	11/1971	Goins
3,664,345	A	5/1972	Dabbs et al.
3,677,243	A	7/1972	Nerz
3,682,180	A	8/1972	McFarlane
3,732,719	A	5/1973	Pallotta
3,750,650	A	8/1973	Ruttgers
3,753,438	A	8/1973	Wood et al.
3,757,629	A	9/1973	Schneider
3,799,172	A	3/1974	Szpur
3,805,337	A	4/1974	Branstetter
3,814,104	A	6/1974	Irnich et al.
3,823,719	A	7/1974	Cummings
3,828,791	A	8/1974	Santos
3,831,608	A	8/1974	Kletschka et al.
3,856,016	A	12/1974	Davis
3,874,388	A	4/1975	King et al.
3,908,662	A	9/1975	Razgulov et al.
3,926,194	A	12/1975	Greenberg et al.
3,931,821	A	1/1976	Kletschka et al.
3,939,820	A	2/1976	Grayzel
3,944,114	A	3/1976	Coppens et al.
3,960,147	A	6/1976	Murray
3,976,079	A	8/1976	Samuels et al.
3,985,138	A	10/1976	Jarvik
4,007,743	A	2/1977	Blake
4,011,872	A	3/1977	Komiya
4,014,492	A	3/1977	Rothfuss
4,018,228	A	4/1977	Goosen
4,046,150	A	9/1977	Schwartz et al.
4,047,533	A	9/1977	Perciaccante et al.
4,064,881	A	12/1977	Meredith
4,112,944	A	9/1978	Williams
4,153,321	A	5/1979	Pombrol
4,162,673	A	7/1979	Patel
4,169,476	A	10/1979	Hiltebrandt
4,189,808	A	2/1980	Brown
4,192,315	A	3/1980	Hilzinger et al.
4,201,215	A	5/1980	Crossett et al.
4,204,541	A	5/1980	Kapitanov
4,207,870	A	6/1980	Eldridge
4,214,587	A	7/1980	Sakura, Jr.
4,215,699	A	8/1980	Patel
4,217,902	A	8/1980	March
4,267,995	A	5/1981	McMillan
4,273,129	A	6/1981	Boebel
4,274,415	A	6/1981	Kanamoto et al.
4,278,091	A	7/1981	Borzone
4,287,489	A	9/1981	Pinkham
4,291,698	A	9/1981	Fuchs et al.
4,317,445	A	3/1982	Robinson
4,317,451	A	3/1982	Cerwin et al.
4,318,401	A	3/1982	Zimmerman
4,327,485	A	5/1982	Rix
4,345,606	A	8/1982	Littleford
4,359,052	A	11/1982	Staub
4,368,736	A	1/1983	Kaster
4,387,489	A	6/1983	Dudek
4,396,139	A	8/1983	Hall et al.
4,400,879	A	8/1983	Hildreth
4,407,286	A	10/1983	Noiles et al.
4,411,654	A	10/1983	Boarini et al.
4,412,832	A	11/1983	Kling et al.
4,428,376	A	1/1984	Mericle
4,440,170	A	4/1984	Golden et al.
4,449,531	A	5/1984	Cerwin et al.
4,475,544	A	10/1984	Reis
4,480,356	A	11/1984	Martin

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,485,816	A	12/1984	Krumme
4,501,276	A	2/1985	Lombardi
RE31,855	E	3/1985	Osborne et al.
4,505,273	A	3/1985	Braun et al.
4,505,274	A	3/1985	Speelman
4,523,591	A	6/1985	Kaplan et al.
4,523,695	A	6/1985	Braun et al.
4,525,157	A	6/1985	Vaillancourt
4,526,174	A	7/1985	Froehlich
4,570,633	A	2/1986	Golden
4,577,635	A	3/1986	Meredith
4,586,503	A	5/1986	Kirsch et al.
4,592,498	A	6/1986	Braun et al.
4,595,559	A	6/1986	Planchamp
4,596,559	A	6/1986	Fleischhacker
4,607,638	A	8/1986	Crainich
4,610,251	A	9/1986	Kumar
4,610,252	A	9/1986	Catalano
4,635,634	A	1/1987	Santos
4,635,637	A	1/1987	Schreiber
4,644,956	A	2/1987	Morgenstern
4,651,737	A	3/1987	Deniega
4,664,305	A	5/1987	Blake et al.
4,665,906	A	5/1987	Jervis
4,667,675	A	5/1987	Davis
4,683,895	A	8/1987	Pohndorf
4,687,469	A	8/1987	Osypka
4,693,249	A	9/1987	Schenck et al.
4,697,312	A	10/1987	Freyer
4,719,917	A	1/1988	Barrows et al.
4,724,840	A	2/1988	McVay et al.
4,738,658	A	4/1988	Magro et al.
4,744,364	A	5/1988	Kensey
4,747,407	A	5/1988	Liu et al.
4,750,492	A	6/1988	Jacobs
4,759,364	A	7/1988	Boebel
4,771,782	A	9/1988	Millar
4,772,266	A	9/1988	Groshong
4,773,421	A	9/1988	Davis
4,777,950	A	10/1988	Kees, Jr.
4,789,090	A	12/1988	Blake, III
4,813,586	A	3/1989	Seifert
4,823,794	A	4/1989	Pierce
4,830,002	A	5/1989	Semm
4,832,688	A	5/1989	Sagae et al.
4,836,204	A	6/1989	Landymore et al.
4,852,568	A	8/1989	Kensey
4,860,746	A	8/1989	Yoon
4,865,026	A	9/1989	Barrett
4,866,818	A	9/1989	Thompson
4,874,122	A	10/1989	Froehlich et al.
4,878,915	A	11/1989	Brantigan
4,885,003	A	12/1989	Hillstead
4,886,067	A	12/1989	Palermo
4,887,601	A	12/1989	Richards
4,890,612	A	1/1990	Kensey
4,902,508	A	2/1990	Badylak et al.
4,917,087	A	4/1990	Walsh et al.
4,917,089	A	4/1990	Sideris
4,929,240	A	5/1990	Kirsch et al.
4,934,364	A	6/1990	Green
4,950,258	A	8/1990	Kawai et al.
4,957,499	A	9/1990	Lipatov et al.
4,961,729	A	10/1990	Vaillancourt
4,967,949	A	11/1990	Sandhaus
4,976,721	A	12/1990	Blasnik et al.
4,983,176	A	1/1991	Cushman et al.
4,997,436	A	3/1991	Oberlander
4,997,439	A	3/1991	Chen
4,997,736	A	3/1991	Kawamura et al.
5,002,562	A	3/1991	Oberlander
5,007,921	A	4/1991	Brown
5,009,663	A	4/1991	Broome
5,011,487	A	4/1991	Shichman
5,015,247	A	5/1991	Michelson
5,021,059	A	6/1991	Kensey et al.
5,026,390	A	6/1991	Brown
5,030,226	A	7/1991	Green et al.
5,032,127	A	7/1991	Frazee et al.
5,035,692	A	7/1991	Lyon et al.
5,041,129	A	8/1991	Hayhurst et al.
5,042,707	A	8/1991	Taheri
5,047,047	A	9/1991	Yoon
5,053,008	A	10/1991	Bajaj
5,059,201	A	10/1991	Asnis
5,061,274	A	10/1991	Kensey
5,061,283	A	10/1991	Silvestrini
5,071,430	A	12/1991	de Salis et al.
5,074,871	A	12/1991	Groshong
5,078,731	A	1/1992	Hayhurst
5,092,941	A	3/1992	Miura
5,100,418	A	3/1992	Yoon et al.
5,100,422	A	3/1992	Berguer et al.
5,108,420	A	4/1992	Marks
5,108,421	A	4/1992	Fowler
5,114,032	A	5/1992	Laidlaw
5,114,065	A	5/1992	Storace
5,116,349	A	5/1992	Aranyi
5,122,122	A	6/1992	Allgood
5,122,156	A	6/1992	Granger et al.
5,131,379	A	7/1992	Sewell, Jr.
5,141,520	A	8/1992	Goble et al.
5,147,381	A	9/1992	Heimerl et al.
5,156,609	A	10/1992	Nakao et al.
5,158,566	A	10/1992	Pianetti
5,160,339	A	11/1992	Chen et al.
5,163,343	A	11/1992	Gish
5,167,634	A	12/1992	Corrigan et al.
5,167,643	A	12/1992	Lynn
5,171,249	A	12/1992	Stefanchik et al.
5,171,250	A	12/1992	Yoon
5,171,251	A	12/1992	Bregen et al.
5,171,259	A	12/1992	Inoue
5,176,648	A	1/1993	Holmes et al.
5,176,682	A	1/1993	Chow
5,176,691	A	1/1993	Pierce
5,192,287	A	3/1993	Fournier et al.
5,192,288	A	3/1993	Thompson et al.
5,192,300	A	3/1993	Fowler
5,192,301	A	3/1993	Kamiya et al.
5,192,302	A	3/1993	Kensey et al.
5,192,602	A	3/1993	Spencer et al.
5,193,533	A	3/1993	Body et al.
5,197,971	A	3/1993	Bonutti
5,203,787	A	4/1993	Noblitt et al.
5,207,697	A	5/1993	Carusillo et al.
5,209,756	A	5/1993	Seedhom et al.
5,211,651	A	5/1993	Reger et al.
5,217,024	A	6/1993	Dorsey et al.
5,217,471	A	6/1993	Burkhart
5,219,359	A	6/1993	McQuilkin et al.
5,222,971	A	6/1993	Willard et al.
5,222,974	A	6/1993	Kensey et al.
5,224,945	A	7/1993	Pannek
5,226,908	A	7/1993	Yoon
5,234,449	A	8/1993	Bruker et al.
5,236,435	A	8/1993	Sewell, Jr.
5,236,445	A	8/1993	Hayhurst et al.
5,237,996	A	8/1993	Waldman et al.
5,242,456	A	9/1993	Nash et al.
5,242,457	A	9/1993	Akopov et al.
5,242,459	A	9/1993	Buelna
5,243,857	A	9/1993	Janota
5,246,156	A	9/1993	Rothfuss et al.
5,246,443	A	9/1993	Mai
5,250,058	A	10/1993	Miller et al.
5,254,105	A	10/1993	Haaga
5,255,679	A	10/1993	Imran
5,258,015	A	11/1993	Li et al.
5,269,792	A	12/1993	Kloeckl et al.
5,275,610	A	1/1994	Eberbach
5,275,616	A	1/1994	Fowler
5,281,422	A	1/1994	Badylak et al.
5,282,808	A	2/1994	Kovac et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,282,827 A 2/1994 Kensey et al.
5,282,832 A 2/1994 Toso et al.
5,284,488 A 2/1994 Sideris
5,289,963 A 3/1994 McGarry et al.
5,290,243 A 3/1994 Chodorow et al.
5,290,310 A 3/1994 Makower et al.
5,292,309 A 3/1994 Van Tassel et al.
5,292,332 A 3/1994 Lee
5,300,046 A 4/1994 Scarfone et al.
5,304,183 A 4/1994 Gourlay et al.
5,304,184 A 4/1994 Hathaway et al.
5,304,204 A 4/1994 Bregen
5,306,254 A 4/1994 Nash et al.
5,306,280 A 4/1994 Bregen et al.
5,309,927 A 5/1994 Welch
5,318,542 A 6/1994 Hirsch et al.
5,320,639 A 6/1994 Rudnick
5,322,694 A 6/1994 Sixsmith
5,327,908 A 7/1994 Gerry
5,328,472 A 7/1994 Steinke et al.
5,330,442 A 7/1994 Green et al.
5,330,445 A 7/1994 Haaga
5,330,503 A 7/1994 Yoon
5,334,216 A 8/1994 Vidal et al.
5,334,217 A 8/1994 Das
5,335,680 A 8/1994 Moore
5,340,360 A 8/1994 Stefanchik
5,342,393 A 8/1994 Stack
5,344,439 A 9/1994 Otten
5,350,399 A 9/1994 Erlebacher et al.
5,352,229 A 10/1994 Goble et al.
5,354,279 A 10/1994 Hofling
5,364,406 A 11/1994 Sewell, Jr.
5,364,408 A 11/1994 Gordon
5,366,458 A 11/1994 Korthoff et al.
5,366,479 A 11/1994 McGarry et al.
5,376,101 A 12/1994 Green et al.
5,383,860 A 1/1995 Lau
5,383,896 A 1/1995 Gershony et al.
5,383,897 A 1/1995 Wholey
5,383,905 A 1/1995 Golds et al.
RE34,866 E 2/1995 Kensey et al.
5,391,173 A 2/1995 Wilk
5,391,174 A 2/1995 Weston
5,392,978 A 2/1995 Velez et al.
5,395,030 A 3/1995 Kuramoto et al.
5,397,355 A 3/1995 Marin et al.
5,403,330 A 4/1995 Tuason
5,403,331 A 4/1995 Chesterfield et al.
5,404,621 A 4/1995 Heinke
5,409,499 A 4/1995 Yi
5,411,520 A 5/1995 Nash et al.
5,413,571 A 5/1995 Katsaros et al.
5,413,584 A 5/1995 Schulze
5,416,584 A 5/1995 Kay
5,417,699 A 5/1995 Klein et al.
5,419,765 A 5/1995 Weldon et al.
5,419,777 A 5/1995 Hofling
5,421,832 A 6/1995 Lefebvre
5,423,857 A 6/1995 Rosenman et al.
5,425,489 A 6/1995 Shichman et al.
5,425,740 A 6/1995 Hutchinson, Jr.
5,431,639 A 7/1995 Shaw
5,431,667 A 7/1995 Thompson et al.
5,433,721 A 7/1995 Hooven et al.
5,437,631 A 8/1995 Janzen
5,439,479 A 8/1995 Shichman et al.
5,443,477 A 8/1995 Marin et al.
5,443,481 A 8/1995 Lee
5,445,167 A 8/1995 Yoon et al.
5,449,359 A 9/1995 Groiso
5,451,235 A 9/1995 Lock et al.
5,454,413 A 10/1995 Morelli
5,456,400 A 10/1995 Shichman et al.
5,462,558 A 10/1995 Kolesa et al.
5,462,561 A 10/1995 Voda
5,464,413 A 11/1995 Siska et al.
5,464,416 A 11/1995 Steckel
5,466,241 A 11/1995 Leroy et al.
5,470,010 A 11/1995 Rothfuss et al.
5,471,982 A 12/1995 Edwards et al.
5,474,557 A 12/1995 Mai
5,474,569 A 12/1995 Zinreich et al.
5,474,572 A 12/1995 Hayhurst
5,476,505 A 12/1995 Limon
5,478,352 A 12/1995 Fowler
5,478,353 A 12/1995 Yoon
5,478,354 A 12/1995 Tovey et al.
5,478,853 A 12/1995 Regnier et al.
5,484,420 A 1/1996 Russo
5,486,195 A 1/1996 Myers et al.
5,492,119 A 2/1996 Abrams
5,496,332 A 3/1996 Sierra et al.
5,497,933 A 3/1996 Defonzo et al.
5,501,698 A 3/1996 Roth et al.
5,507,744 A 4/1996 Tay et al.
5,507,755 A 4/1996 Gresl et al.
5,510,115 A 4/1996 Breillatt et al.
5,514,159 A 5/1996 Matula et al.
5,521,184 A 5/1996 Zimmermann
5,522,840 A 6/1996 Krajicek
5,527,322 A 6/1996 Klein et al.
5,536,251 A 7/1996 Evard et al.
5,536,267 A 7/1996 Edwards et al.
5,540,712 A 7/1996 Kleshinski et al.
5,540,716 A 7/1996 Hlavacek
5,543,520 A 8/1996 Zimmermann
5,544,802 A 8/1996 Crainich
5,545,178 A 8/1996 Kensey et al.
5,547,474 A 8/1996 Kloeckl et al.
5,560,532 A 10/1996 Defonzo et al.
5,562,684 A 10/1996 Kammerer
5,571,120 A 11/1996 Yoon
5,573,540 A 11/1996 Yoon
5,573,784 A 11/1996 Badylak et al.
5,575,771 A 11/1996 Walinsky
5,582,616 A 12/1996 Bolduc et al.
5,584,879 A 12/1996 Reimold et al.
5,591,205 A 1/1997 Fowler
5,593,412 A 1/1997 Martinez et al.
5,593,422 A 1/1997 Muijs et al.
5,593,425 A 1/1997 Bonutti et al.
5,601,602 A 2/1997 Fowler
5,609,597 A 3/1997 Lehrer
5,611,986 A 3/1997 Datta et al.
5,613,974 A 3/1997 Andreas et al.
5,613,975 A 3/1997 Christy
5,618,291 A 4/1997 Thompson et al.
5,618,306 A 4/1997 Roth et al.
5,620,452 A 4/1997 Yoon
5,620,461 A 4/1997 Muijs et al.
5,626,614 A 5/1997 Hart
5,630,824 A 5/1997 Hart
5,634,936 A 6/1997 Linden et al.
5,643,318 A 7/1997 Tsukernik et al.
5,645,553 A 7/1997 Kolesa et al.
5,645,565 A 7/1997 Rudd et al.
5,645,566 A 7/1997 Brenneman et al.
5,645,567 A 7/1997 Crainich
5,647,372 A 7/1997 Tovey et al.
5,649,959 A 7/1997 Hannam et al.
D383,539 S 9/1997 Croley et al.
5,669,917 A 9/1997 Sauer et al.
5,669,935 A 9/1997 Rosenman et al.
5,672,174 A 9/1997 Gough et al.
5,674,231 A 10/1997 Green et al.
5,674,244 A 10/1997 Mathys
5,676,689 A 10/1997 Kensey et al.
5,676,974 A 10/1997 Valdes et al.
5,678,572 A 10/1997 Shaw et al.
5,681,280 A 10/1997 Rusk et al.
5,681,334 A 10/1997 Evans et al.
5,681,351 A 10/1997 Jamiolkowski et al.
5,683,405 A 11/1997 Yacoubian et al.

(56) **References Cited**

U.S. PATENT DOCUMENTS

5,690,674 A 11/1997 Diaz
5,693,061 A 12/1997 Pierce et al.
5,695,504 A 12/1997 Gifford et al.
5,695,505 A 12/1997 Yoon
5,695,524 A 12/1997 Kelley et al.
5,697,943 A 12/1997 Sauer et al.
5,700,270 A 12/1997 Peyser et al.
5,700,273 A 12/1997 Buelna et al.
5,709,224 A 1/1998 Behl et al.
5,709,708 A 1/1998 Thal
5,713,899 A 2/1998 Marnay et al.
5,715,987 A 2/1998 Kelley et al.
5,716,375 A 2/1998 Fowler
5,720,755 A 2/1998 Dakov
5,720,765 A 2/1998 Thal
5,725,498 A 3/1998 Janzen et al.
5,725,552 A 3/1998 Kotula et al.
5,725,554 A 3/1998 Simon et al.
5,725,556 A 3/1998 Moser et al.
5,728,109 A 3/1998 Schulze et al.
5,728,110 A 3/1998 Vidal et al.
5,728,114 A 3/1998 Evans et al.
5,728,116 A 3/1998 Rosenman
5,728,122 A 3/1998 Leschinsky et al.
5,728,132 A 3/1998 Van et al.
5,728,133 A 3/1998 Kontos
5,728,143 A 3/1998 Gough et al.
5,732,872 A 3/1998 Bolduc et al.
5,735,736 A 4/1998 Volk
5,735,873 A 4/1998 Maclean
5,735,875 A 4/1998 Bonutti et al.
5,735,877 A 4/1998 Pagedas
5,746,753 A 5/1998 Sullivan et al.
5,749,826 A 5/1998 Faulkner
5,749,898 A 5/1998 Schulze et al.
5,752,966 A 5/1998 Chang
5,755,726 A 5/1998 Pratt et al.
5,755,727 A 5/1998 Kontos
5,755,778 A 5/1998 Kleshinski
5,759,189 A 6/1998 Ferragamo et al.
5,762,872 A 6/1998 Buehler et al.
5,766,217 A 6/1998 Christy
5,766,246 A 6/1998 Mulhauser et al.
5,769,862 A 6/1998 Kammerer et al.
5,769,870 A 6/1998 Salahieh et al.
5,776,147 A 7/1998 Dolendo
5,776,150 A 7/1998 Nolan et al.
5,779,707 A 7/1998 Bertholet et al.
5,780,807 A 7/1998 Saunders
5,782,844 A 7/1998 Yoon et al.
5,782,860 A 7/1998 Epstein et al.
5,782,861 A 7/1998 Cragg et al.
5,782,864 A 7/1998 Lizardi
5,795,958 A 8/1998 Rao et al.
5,797,928 A 8/1998 Kogasaka
5,797,929 A 8/1998 Andreas et al.
5,797,931 A 8/1998 Bito et al.
5,797,933 A 8/1998 Snow et al.
5,797,958 A 8/1998 Yoon
5,797,960 A 8/1998 Stevens et al.
5,810,776 A 9/1998 Bacich et al.
5,810,846 A 9/1998 Virnich et al.
5,810,851 A 9/1998 Yoon
5,810,877 A 9/1998 Roth et al.
5,814,069 A 9/1998 Schulze et al.
5,817,113 A 10/1998 Gifford et al.
5,820,631 A 10/1998 Nobles
5,823,189 A 10/1998 Kordis
5,827,298 A 10/1998 Hart et al.
5,830,125 A 11/1998 Scribner et al.
5,830,217 A 11/1998 Ryan
5,830,221 A 11/1998 Stein et al.
5,833,698 A 11/1998 Hinchliffe et al.
5,843,164 A 12/1998 Frantzen et al.
5,843,167 A 12/1998 Dwyer et al.
5,845,657 A 12/1998 Carberry et al.
5,846,254 A 12/1998 Schulze et al.
5,853,421 A 12/1998 Leschinsky et al.
5,853,422 A 12/1998 Huebsch et al.
5,855,312 A 1/1999 Toledano
5,855,576 A 1/1999 Leveen et al.
5,857,999 A 1/1999 Quick et al.
5,858,082 A 1/1999 Cruz et al.
5,860,991 A 1/1999 Klein et al.
5,861,003 A 1/1999 Latson et al.
5,861,005 A 1/1999 Kontos
5,865,791 A 2/1999 Whayne et al.
5,868,755 A 2/1999 Kanner et al.
5,868,762 A 2/1999 Cragg et al.
5,868,763 A 2/1999 Spence et al.
5,871,474 A 2/1999 Hermann et al.
5,871,490 A 2/1999 Schulze et al.
5,871,501 A 2/1999 Leschinsky et al.
5,871,525 A 2/1999 Edwards et al.
5,873,876 A 2/1999 Christy
5,873,891 A 2/1999 Sohn
5,879,366 A 3/1999 Shaw et al.
5,891,088 A 4/1999 Thompson et al.
5,893,592 A 4/1999 Schulze et al.
5,897,487 A 4/1999 Ouchi
5,902,310 A 5/1999 Foerster et al.
5,904,696 A 5/1999 Rosenman
5,904,697 A 5/1999 Gifford et al.
5,904,703 A 5/1999 Gilson
5,906,631 A 5/1999 Imran
5,907,893 A 6/1999 Zadno-Azizi et al.
5,908,149 A 6/1999 Welch et al.
5,910,155 A 6/1999 Ratcliff et al.
5,919,207 A 7/1999 Taheri
5,919,208 A 7/1999 Valenti
5,922,009 A 7/1999 Epstein et al.
5,928,208 A 7/1999 Chu et al.
5,928,231 A 7/1999 Klein et al.
5,928,251 A 7/1999 Aranyi et al.
5,928,260 A 7/1999 Chin et al.
5,935,147 A 8/1999 Kensey et al.
5,938,667 A 8/1999 Peyser et al.
5,941,890 A 8/1999 Voegele et al.
5,947,999 A 9/1999 Groiso
5,948,001 A 9/1999 Larsen
5,951,518 A 9/1999 Licata et al.
5,951,547 A 9/1999 Gough et al.
5,951,575 A 9/1999 Bolduc et al.
5,951,576 A 9/1999 Wakabayashi
5,951,589 A 9/1999 Epstein et al.
5,954,732 A * 9/1999 Hart A61B 17/0469 606/144
5,957,900 A 9/1999 Ouchi
5,957,936 A 9/1999 Yoon et al.
5,957,938 A 9/1999 Zhu et al.
5,957,940 A 9/1999 Tanner et al.
5,964,782 A 10/1999 Lafontaine et al.
5,972,023 A 10/1999 Tanner et al.
5,976,159 A 11/1999 Bolduc et al.
5,976,161 A 11/1999 Kirsch et al.
5,976,174 A 11/1999 Ruiz
5,980,517 A 11/1999 Gough
5,984,934 A 11/1999 Ashby et al.
5,984,948 A 11/1999 Hasson
5,984,949 A 11/1999 Levin
5,993,466 A 11/1999 Yoon
5,993,468 A 11/1999 Rygaard
5,993,476 A 11/1999 Groiso
6,001,110 A 12/1999 Adams
6,004,341 A 12/1999 Zhu et al.
6,007,563 A 12/1999 Nash et al.
6,007,574 A 12/1999 Pulnev et al.
6,009,877 A 1/2000 Edwards
6,010,517 A 1/2000 Baccaro
6,013,084 A 1/2000 Ken et al.
6,015,815 A 1/2000 Mollison
6,019,779 A 2/2000 Thorud et al.
6,022,372 A 2/2000 Kontos
6,024,747 A 2/2000 Kontos

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,024,750 A 2/2000 Mastri et al.
6,024,756 A 2/2000 Huebsch et al.
6,024,758 A 2/2000 Thal
6,030,364 A 2/2000 Durgin et al.
6,030,413 A 2/2000 Lazarus
6,033,427 A 3/2000 Lee
6,036,703 A 3/2000 Evans et al.
6,036,720 A 3/2000 Abrams et al.
6,045,570 A 4/2000 Epstein et al.
6,048,358 A 4/2000 Barak
6,056,688 A 5/2000 Benderev et al.
6,056,744 A 5/2000 Edwards
6,056,768 A 5/2000 Cates et al.
6,056,769 A 5/2000 Epstein et al.
6,056,770 A 5/2000 Epstein et al.
6,059,800 A 5/2000 Hart et al.
6,059,825 A 5/2000 Hobbs et al.
6,063,085 A 5/2000 Tay et al.
6,063,114 A 5/2000 Nash et al.
6,066,160 A 5/2000 Colvin et al.
6,068,603 A 5/2000 Suzuki
6,071,300 A 6/2000 Brenneman et al.
6,074,395 A 6/2000 Trott et al.
6,074,409 A 6/2000 Goldfarb
6,077,281 A 6/2000 Das
6,077,291 A 6/2000 Das
6,080,182 A 6/2000 Shaw et al.
6,080,183 A 6/2000 Tsugita et al.
6,083,242 A 7/2000 Cook
6,086,608 A 7/2000 Ek et al.
6,090,130 A 7/2000 Nash et al.
6,092,561 A 7/2000 Schmid
6,095,155 A 8/2000 Criscuolo
6,099,553 A 8/2000 Hart et al.
6,102,271 A 8/2000 Longo et al.
6,105,217 A 8/2000 Caradine et al.
6,106,545 A 8/2000 Egan
6,110,184 A 8/2000 Weadock
6,113,610 A 9/2000 Poncet
6,113,611 A 9/2000 Allen et al.
6,113,612 A 9/2000 Swanson et al.
6,117,125 A 9/2000 Rothbarth et al.
6,117,144 A 9/2000 Nobles et al.
6,117,148 A 9/2000 Ravo et al.
6,117,157 A 9/2000 Tekulve
6,117,159 A 9/2000 Huebsch et al.
6,120,513 A 9/2000 Bailey et al.
6,120,524 A 9/2000 Taheri
6,126,675 A 10/2000 Shchervinsky et al.
6,126,677 A 10/2000 Ganaja et al.
6,136,010 A 10/2000 Modesitt et al.
6,143,004 A 11/2000 Davis et al.
6,143,017 A 11/2000 Thal
6,146,385 A 11/2000 Torrie et al.
6,149,660 A 11/2000 Laufer et al.
6,149,667 A 11/2000 Hovland et al.
6,152,144 A 11/2000 Lesh et al.
6,152,934 A 11/2000 Harper et al.
6,152,936 A 11/2000 Christy et al.
6,152,937 A 11/2000 Peterson et al.
6,159,234 A 12/2000 Bonutti et al.
6,161,263 A 12/2000 Anderson
6,165,204 A 12/2000 Levinson et al.
6,171,277 B1 1/2001 Ponzi
6,171,329 B1 1/2001 Shaw et al.
6,174,322 B1 1/2001 Schneidt
6,174,324 B1 1/2001 Egan et al.
6,179,849 B1 1/2001 Yencho et al.
6,179,860 B1 1/2001 Fulton et al.
6,183,775 B1 2/2001 Ventouras
6,193,708 B1 2/2001 Ken et al.
6,193,734 B1 2/2001 Bolduc et al.
6,197,042 B1 3/2001 Ginn et al.
6,198,974 B1 3/2001 Webster, Jr.
6,200,329 B1 3/2001 Fung et al.
6,200,330 B1 3/2001 Benderev et al.
6,203,565 B1 3/2001 Bonutti et al.
6,206,895 B1 3/2001 Levinson
6,206,913 B1 3/2001 Yencho et al.
6,206,931 B1 3/2001 Cook et al.
6,210,407 B1 4/2001 Webster
6,210,418 B1 4/2001 Storz et al.
6,217,554 B1 4/2001 Green
6,220,248 B1 4/2001 Voegele et al.
6,221,084 B1 4/2001 Fleenor
6,221,102 B1 4/2001 Baker et al.
6,231,561 B1 5/2001 Frazier et al.
6,231,592 B1 5/2001 Bonutti et al.
6,238,705 B1 5/2001 Liu et al.
6,241,740 B1 6/2001 Davis et al.
6,245,079 B1 6/2001 Nobles et al.
6,248,124 B1 6/2001 Pedros et al.
6,254,615 B1 7/2001 Bolduc et al.
6,254,617 B1 7/2001 Spence et al.
6,254,642 B1 7/2001 Taylor
6,258,115 B1 7/2001 Dubrul
6,267,773 B1 7/2001 Gadberry et al.
6,273,903 B1 8/2001 Wilk
6,276,704 B1 8/2001 Suiter
6,277,140 B2 8/2001 Ginn et al.
6,280,460 B1 8/2001 Bolduc et al.
6,287,322 B1 9/2001 Zhu et al.
6,287,335 B1 9/2001 Drasler et al.
6,290,674 B1 9/2001 Roue et al.
6,296,657 B1 10/2001 Brucker
6,302,870 B1 10/2001 Jacobsen et al.
6,302,898 B1 10/2001 Edwards et al.
6,305,891 B1 10/2001 Burlingame
6,306,081 B1 10/2001 Ishikawa et al.
6,309,416 B1 10/2001 Swanson et al.
6,319,258 B1 11/2001 McAllen et al.
6,322,580 B1 11/2001 Kanner
6,328,727 B1 12/2001 Frazier et al.
6,329,386 B1 12/2001 Mollison
6,334,865 B1 1/2002 Redmond et al.
6,348,064 B1 2/2002 Kanner
6,355,052 B1 3/2002 Neuss et al.
6,355,061 B1 3/2002 Quiachon et al.
6,358,258 B1 3/2002 Arcia et al.
6,375,671 B1 4/2002 Kobayashi et al.
D457,958 S 5/2002 Dycus et al.
6,383,208 B1 5/2002 Sancoff et al.
6,391,048 B1 5/2002 Ginn et al.
6,395,015 B1 5/2002 Borst et al.
6,397,110 B1 5/2002 Kuzma
6,398,752 B1 6/2002 Sweezer et al.
6,402,765 B1 6/2002 Monassevitch et al.
6,409,739 B1 6/2002 Nobles et al.
6,419,669 B1 7/2002 Frazier et al.
6,421,899 B1 7/2002 Zitnay
6,423,054 B1 7/2002 Ouchi
6,425,911 B1 7/2002 Akerfeldt et al.
6,428,472 B1 8/2002 Haas
6,428,548 B1 8/2002 Durgin et al.
6,443,158 B1 9/2002 Lafontaine et al.
6,443,963 B1 9/2002 Baldwin et al.
6,447,540 B1 9/2002 Fontaine et al.
6,450,391 B1 9/2002 Kayan et al.
6,455,053 B1 9/2002 Okada et al.
6,458,130 B1 10/2002 Frazier et al.
6,461,327 B1 10/2002 Addis et al.
6,461,364 B1 10/2002 Ginn et al.
6,461,366 B1 10/2002 Seguin
6,482,224 B1 11/2002 Michler et al.
6,485,504 B1 11/2002 Johnson et al.
6,488,692 B1 12/2002 Spence et al.
6,494,848 B1 12/2002 Sommercorn et al.
6,500,115 B2 12/2002 Krattiger et al.
6,505,210 B1 1/2003 Frey et al.
6,506,210 B1 1/2003 Kanner
6,508,828 B1 1/2003 Akerfeldt et al.
6,514,280 B1 2/2003 Gilson
6,517,498 B1 2/2003 Burbank et al.
6,517,555 B1 2/2003 Caro

(56) **References Cited**

U.S. PATENT DOCUMENTS

6,517,569 B2 2/2003 Mikus et al.
6,527,737 B2 3/2003 Kaneshige
6,533,762 B2 3/2003 Kanner et al.
6,533,812 B2 3/2003 Swanson et al.
6,537,288 B2 3/2003 Vargas et al.
6,544,230 B1 4/2003 Flaherty et al.
6,547,806 B1 4/2003 Ding
6,551,319 B2 4/2003 Lieberman
6,558,349 B1 5/2003 Kirkman
6,569,159 B1 5/2003 Edwards et al.
6,569,173 B1 5/2003 Blatter et al.
6,569,185 B2 5/2003 Ungs
6,572,629 B2 6/2003 Kalloo et al.
6,578,585 B1 6/2003 Stachowski et al.
6,582,452 B2 6/2003 Coleman et al.
6,582,482 B2 6/2003 Gillman et al.
6,596,012 B2 7/2003 Akerfeldt et al.
6,596,013 B2 7/2003 Yang et al.
6,599,303 B1 7/2003 Peterson et al.
6,599,311 B1 7/2003 Biggs et al.
6,602,263 B1 8/2003 Swanson et al.
6,610,072 B1 8/2003 Christy et al.
6,613,059 B2 9/2003 Schaller et al.
6,613,060 B2 9/2003 Adams et al.
6,616,686 B2 9/2003 Coleman et al.
6,620,165 B2 9/2003 Wellisz
6,623,509 B2 9/2003 Ginn
6,623,510 B2 9/2003 Carley et al.
6,626,918 B1 9/2003 Ginn et al.
6,626,919 B1 9/2003 Swanstrom
6,626,920 B2 9/2003 Whayne
6,626,930 B1 9/2003 Allen et al.
6,632,197 B2 10/2003 Lyon
6,632,238 B2 10/2003 Ginn et al.
6,634,537 B2 10/2003 Chen
6,645,205 B2 11/2003 Ginn
6,645,225 B1 11/2003 Atkinson
6,645,255 B2 11/2003 Sanduja et al.
6,652,538 B2 11/2003 Kayan et al.
6,652,556 B1 11/2003 Vantassel et al.
6,663,633 B1 12/2003 Pierson, III
6,663,655 B2 12/2003 Ginn et al.
6,665,906 B2 12/2003 Li
6,669,714 B2 12/2003 Coleman et al.
6,673,083 B1 1/2004 Kayan et al.
6,676,665 B2 1/2004 Foley et al.
6,676,671 B2 1/2004 Robertson et al.
6,676,685 B2 1/2004 Pedros et al.
6,679,894 B2 1/2004 Damarati
6,679,904 B2 1/2004 Gleeson et al.
6,685,707 B2 2/2004 Roman et al.
6,689,147 B1 2/2004 Koster, Jr.
6,695,867 B2 2/2004 Ginn et al.
6,699,256 B1 3/2004 Logan et al.
6,702,826 B2 3/2004 Liddicoat et al.
6,712,836 B1 3/2004 Berg et al.
6,712,837 B2 3/2004 Aakerfeldt et al.
6,719,777 B2 4/2004 Ginn et al.
6,726,704 B1 4/2004 Loshakove et al.
6,736,822 B2 5/2004 McClellan et al.
6,743,195 B2 6/2004 Zucker
6,743,243 B1 6/2004 Roy et al.
6,743,259 B2 6/2004 Ginn
6,745,079 B2 6/2004 King
6,746,457 B2 6/2004 Dana et al.
6,746,472 B2 6/2004 Frazier et al.
6,749,621 B2 6/2004 Pantages et al.
6,749,622 B2 6/2004 McGuckin et al.
6,752,813 B2 6/2004 Goldfarb et al.
6,755,842 B2 6/2004 Kanner et al.
6,758,855 B2 7/2004 Fulton et al.
6,767,356 B2 7/2004 Kanner et al.
6,776,784 B2 8/2004 Ginn
6,776,785 B1 8/2004 Yencho et al.
6,780,185 B2 8/2004 Frei et al.
6,780,197 B2 8/2004 Roe et al.
6,786,915 B2 9/2004 Akerfeldt et al.
6,790,218 B2 9/2004 Jayaraman
6,790,220 B2 9/2004 Morris et al.
6,837,893 B2 1/2005 Miller
6,837,906 B2 1/2005 Ginn
6,846,319 B2 1/2005 Ginn et al.
6,849,078 B2 2/2005 Durgin et al.
6,860,895 B1 3/2005 Akerfeldt et al.
6,890,343 B2 5/2005 Ginn et al.
6,896,687 B2 5/2005 Dakov
6,896,692 B2 5/2005 Ginn et al.
6,904,647 B2 6/2005 Byers, Jr.
6,913,607 B2 7/2005 Ainsworth et al.
6,926,723 B1 8/2005 Mulhauser et al.
6,926,731 B2 8/2005 Coleman et al.
6,929,634 B2 8/2005 Dorros et al.
6,942,641 B2 9/2005 Seddon
6,942,674 B2 9/2005 Belef et al.
6,942,691 B1 9/2005 Chuter
6,964,668 B2 11/2005 Modesitt et al.
6,969,391 B1 11/2005 Gazzani
6,969,397 B2 11/2005 Ginn
6,984,238 B2 1/2006 Gifford et al.
6,989,003 B2 1/2006 Wing et al.
6,989,016 B2 1/2006 Tallarida et al.
7,001,398 B2 2/2006 Carley et al.
7,001,400 B1 2/2006 Modesitt et al.
7,008,435 B2 3/2006 Cummins
7,008,439 B1 3/2006 Janzen et al.
7,025,776 B1 4/2006 Houser et al.
7,033,379 B2 4/2006 Peterson
7,048,747 B2 5/2006 Arcia et al.
7,060,084 B1 6/2006 Loshakove et al.
7,063,711 B1 6/2006 Loshakove et al.
7,074,232 B2 7/2006 Kanner et al.
7,076,305 B2 7/2006 Imran et al.
7,083,635 B2 8/2006 Ginn
7,087,064 B1 8/2006 Hyde
7,087,088 B2 8/2006 Berg et al.
7,094,245 B2 8/2006 Adams et al.
7,108,709 B2 9/2006 Cummins
7,108,710 B2 9/2006 Anderson
7,111,768 B2 9/2006 Cummins et al.
7,112,225 B2 9/2006 Ginn
7,122,002 B2 10/2006 Okada
7,144,411 B2 12/2006 Ginn et al.
7,147,646 B2 12/2006 Dana et al.
7,163,551 B2 1/2007 Anthony et al.
7,169,158 B2 1/2007 Sniffin et al.
7,169,164 B2 1/2007 Borillo et al.
7,175,646 B2 2/2007 Brenneman et al.
7,211,101 B2 5/2007 Carley et al.
7,220,268 B2 5/2007 Blatter
7,229,452 B2 6/2007 Kayan
7,261,716 B2 8/2007 Strobel et al.
7,270,672 B1 9/2007 Singer
7,306,614 B2 12/2007 Weller et al.
7,311,720 B2 12/2007 Mueller et al.
7,316,704 B2 1/2008 Bagaoisan et al.
7,316,706 B2 1/2008 Bloom et al.
7,322,995 B2 1/2008 Buckman et al.
7,326,230 B2 2/2008 Ravikumar
7,331,979 B2 2/2008 Khosravi et al.
7,335,220 B2 2/2008 Khosravi et al.
D566,272 S 4/2008 Walburg et al.
7,361,178 B2 4/2008 Hearn et al.
7,361,183 B2 4/2008 Ginn
7,361,185 B2 4/2008 O'Malley et al.
7,393,363 B2 7/2008 Ginn
7,396,359 B1 7/2008 Derowe et al.
7,431,727 B2 10/2008 Cole et al.
7,431,729 B2 10/2008 Chanduszko
7,445,596 B2 11/2008 Kucklick et al.
7,449,011 B2 11/2008 Wenchell et al.
7,452,327 B2 11/2008 Durgin et al.
7,462,188 B2 12/2008 McIntosh
7,465,286 B2 12/2008 Patterson et al.
7,507,200 B2 3/2009 Okada

(56) **References Cited**

U.S. PATENT DOCUMENTS

7,533,790 B1 5/2009 Knodel et al.
7,556,632 B2 7/2009 Zadno
7,582,103 B2 9/2009 Young et al.
7,582,104 B2 9/2009 Corcoran et al.
7,597,706 B2 10/2009 Kanner et al.
7,618,427 B2 11/2009 Ortiz et al.
7,622,628 B2 11/2009 Bergin et al.
7,632,287 B2 12/2009 Baker et al.
7,645,285 B2 1/2010 Cosgrove et al.
D611,144 S 3/2010 Reynolds et al.
7,678,135 B2 3/2010 Maahs et al.
7,727,249 B2 6/2010 Rahmani
7,731,655 B2 6/2010 Smith et al.
7,749,249 B2 7/2010 Gelbart et al.
7,780,696 B2 8/2010 Daniel et al.
7,799,042 B2 9/2010 Williamson et al.
7,806,904 B2 10/2010 Carley et al.
7,819,895 B2 10/2010 Ginn et al.
7,824,419 B2 11/2010 Boraiah
7,841,502 B2 11/2010 Walberg et al.
7,842,068 B2 11/2010 Ginn
7,850,709 B2 12/2010 Cummins et al.
7,850,797 B2 12/2010 Carley et al.
7,854,810 B2 12/2010 Carley et al.
7,857,828 B2 12/2010 Jabba et al.
7,867,249 B2 1/2011 Palermo et al.
7,875,054 B2 1/2011 Lafontaine
7,879,071 B2 2/2011 Carley et al.
7,887,555 B2 2/2011 Carley et al.
7,887,563 B2 2/2011 Cummins
7,901,428 B2 3/2011 Ginn et al.
7,905,900 B2 3/2011 Palermo et al.
7,918,873 B2 4/2011 Cummins
7,931,669 B2 4/2011 Ginn et al.
7,931,671 B2 4/2011 Tenerz
7,967,842 B2 6/2011 Bakos
8,007,512 B2 8/2011 Ginn et al.
8,038,688 B2 10/2011 Modesitt et al.
8,083,768 B2 12/2011 Ginn et al.
8,103,327 B2 1/2012 Harlev et al.
8,105,352 B2 1/2012 Egneloev
8,128,644 B2 3/2012 Carley et al.
8,172,749 B2 5/2012 Melsheimer
8,182,497 B2 5/2012 Carley et al.
8,192,459 B2 6/2012 Cummins et al.
8,202,283 B2 6/2012 Carley et al.
8,202,293 B2 6/2012 Ellingwood et al.
8,202,294 B2 6/2012 Jabba et al.
8,211,122 B2 7/2012 McIntosh
8,216,260 B2 7/2012 Lam et al.
8,226,666 B2 7/2012 Zarbatany et al.
8,226,681 B2 7/2012 Clark et al.
8,236,026 B2 8/2012 Carley et al.
8,257,390 B2 9/2012 Carley et al.
8,303,624 B2 11/2012 Fortson
8,313,497 B2 * 11/2012 Walberg A61B 17/0057 606/213
8,323,312 B2 12/2012 Clark
8,398,656 B2 3/2013 Palermo et al.
8,398,676 B2 3/2013 Roorda et al.
8,403,929 B2 3/2013 Weisshaupt et al.
8,409,228 B2 4/2013 Blatter et al.
8,469,995 B2 6/2013 Cummins et al.
8,475,468 B2 7/2013 Leckrone et al.
8,486,092 B2 7/2013 Carley et al.
8,486,108 B2 7/2013 Carley et al.
8,491,609 B2 7/2013 Stone
8,518,057 B2 * 8/2013 Walberg A61B 17/068 606/213
8,529,587 B2 9/2013 Ellingwood et al.
8,556,930 B2 10/2013 Ellingwood
8,562,630 B2 10/2013 Campbell
8,574,244 B2 11/2013 Reynolds
8,579,932 B2 11/2013 Pantages et al.
8,579,933 B2 11/2013 Chen et al.
8,585,836 B2 11/2013 Carley et al.
8,590,760 B2 11/2013 Cummins et al.
8,597,325 B2 12/2013 Ginn
8,603,116 B2 12/2013 Roorda
8,603,136 B2 12/2013 Ginn
8,617,184 B2 12/2013 Oepen
8,657,852 B2 2/2014 Roorda et al.
8,672,953 B2 3/2014 Reyes et al.
8,690,910 B2 4/2014 Carley et al.
8,728,119 B2 5/2014 Cummins
8,758,396 B2 6/2014 Ginn et al.
8,758,398 B2 6/2014 Carley
8,758,399 B2 6/2014 Fortson et al.
8,758,400 B2 6/2014 Ginn et al.
8,784,447 B2 7/2014 Coleman et al.
8,808,310 B2 8/2014 Jones et al.
8,820,602 B2 9/2014 Walberg et al.
8,821,534 B2 9/2014 Voss
8,834,494 B2 9/2014 Schorr et al.
8,858,594 B2 10/2014 Clark
8,893,947 B2 11/2014 Reynolds et al.
8,905,937 B2 12/2014 Ellingwood et al.
8,926,633 B2 1/2015 Carly
8,926,656 B2 1/2015 Palermo et al.
8,956,388 B2 2/2015 Ginn et al.
8,992,549 B2 3/2015 Bennett, III
9,050,068 B2 * 6/2015 Walberg A61B 17/068
9,050,087 B2 6/2015 Ginn et al.
9,060,769 B2 6/2015 Coleman et al.
9,089,311 B2 7/2015 Fortson et al.
9,089,674 B2 7/2015 Ginn et al.
9,149,276 B2 10/2015 Voss
9,173,644 B2 11/2015 Voss
9,241,696 B2 1/2016 Mehl
9,271,707 B2 3/2016 Palermo et al.
9,282,965 B2 3/2016 Kokish
9,295,469 B2 3/2016 Cummins et al.
9,314,230 B2 4/2016 Roorda et al.
9,320,522 B2 4/2016 Carley et al.
9,332,976 B2 5/2016 Yribarren
9,345,460 B2 5/2016 Houser et al.
9,364,209 B2 6/2016 Voss
9,398,914 B2 7/2016 Ellingwood et al.
9,402,625 B2 8/2016 Coleman et al.
9,414,820 B2 8/2016 Voss et al.
9,414,824 B2 8/2016 Fortson et al.
9,486,191 B2 11/2016 Gianotti et al.
9,498,196 B2 11/2016 Pantages et al.
9,554,786 B2 1/2017 Carley et al.
9,579,091 B2 2/2017 Ginn et al.
9,585,646 B2 3/2017 Carley et al.
9,585,647 B2 3/2017 Clark
9,962,144 B2 5/2018 Ellingwood
9,980,728 B2 5/2018 Cummins et al.
10,085,753 B2 10/2018 Walberg et al.
10,111,664 B2 10/2018 Ginn et al.
10,201,340 B2 2/2019 Pantages et al.
10,245,013 B2 4/2019 Carley et al.
11,399,815 B2 8/2022 Yassinzadeh et al.
11,439,378 B2 9/2022 Gianotti et al.
2001/0021855 A1 9/2001 Levinson
2001/0031973 A1 10/2001 Nobles et al.
2001/0044639 A1 11/2001 Levinson
2001/0046518 A1 11/2001 Sawhney
2001/0047180 A1 11/2001 Grudem et al.
2002/0022822 A1 2/2002 Cragg et al.
2002/0026208 A1 * 2/2002 Roe A61B 34/76 606/139
2002/0026215 A1 2/2002 Redmond et al.
2002/0026216 A1 2/2002 Grimes
2002/0029050 A1 3/2002 Gifford et al.
2002/0038127 A1 3/2002 Blatter et al.
2002/0049427 A1 4/2002 Wiener et al.
2002/0049453 A1 4/2002 Nobles et al.
2002/0056460 A1 5/2002 Boyd et al.
2002/0058960 A1 5/2002 Hudson et al.
2002/0062104 A1 5/2002 Ashby et al.
2002/0095164 A1 7/2002 Andreas et al.
2002/0095181 A1 7/2002 Beyar

(56) **References Cited**

U.S. PATENT DOCUMENTS

2002/0099389 A1 7/2002 Michler et al.
2002/0106409 A1 8/2002 Sawhney et al.
2002/0151963 A1 10/2002 Brown et al.
2002/0169475 A1 11/2002 Gainor et al.
2002/0183786 A1 12/2002 Girton
2002/0183787 A1 12/2002 Wahr et al.
2002/0188275 A1 12/2002 McGuckin
2002/0198589 A1 12/2002 Leong
2003/0004543 A1 1/2003 Gleeson et al.
2003/0009180 A1 1/2003 Hinchliffe et al.
2003/0018358 A1 1/2003 Saadat
2003/0023248 A1 1/2003 Parodi
2003/0033006 A1 2/2003 Phillips et al.
2003/0060846 A1 3/2003 Egnelov et al.
2003/0065358 A1 4/2003 Frecker et al.
2003/0083679 A1 5/2003 Grudem et al.
2003/0088269 A1 5/2003 Ashby
2003/0093108 A1 5/2003 Avellanet et al.
2003/0097140 A1 5/2003 Kanner
2003/0109890 A1 6/2003 Kanner et al.
2003/0125766 A1 7/2003 Ding
2003/0139819 A1 7/2003 Beer et al.
2003/0144695 A1 7/2003 McGuckin et al.
2003/0167063 A1 9/2003 Kerr
2003/0195504 A1 10/2003 Tallarida et al.
2003/0208211 A1 11/2003 Kortenbach
2003/0233095 A1 12/2003 Urbanski et al.
2004/0002763 A1 1/2004 Phillips et al.
2004/0009205 A1 1/2004 Sawhney
2004/0044350 A1 3/2004 Martin et al.
2004/0049224 A1 3/2004 Buehlmann et al.
2004/0059376 A1 3/2004 Breuniger
2004/0068273 A1 4/2004 Fariss et al.
2004/0078053 A1 4/2004 Berg et al.
2004/0087985 A1 5/2004 Loshakove et al.
2004/0092962 A1 5/2004 Thornton et al.
2004/0092964 A1 5/2004 Modesitt et al.
2004/0092968 A1 5/2004 Caro et al.
2004/0092973 A1 5/2004 Chanduszko et al.
2004/0093024 A1 5/2004 Lousararian et al.
2004/0093027 A1 5/2004 Fabisiak et al.
2004/0097978 A1 5/2004 Modesitt et al.
2004/0106980 A1 6/2004 Solovay et al.
2004/0127940 A1 7/2004 Ginn et al.
2004/0143261 A1 7/2004 Hartley et al.
2004/0143290 A1 7/2004 Brightbill
2004/0143291 A1 7/2004 Corcoran et al.
2004/0147957 A1 7/2004 Pierson
2004/0153123 A1* 8/2004 Palermo A61B 17/0644 606/213
2004/0158287 A1 8/2004 Cragg et al.
2004/0158309 A1 8/2004 Wachter et al.
2004/0167511 A1 8/2004 Buehlmann et al.
2004/0191277 A1 9/2004 Sawhney et al.
2004/0215232 A1 10/2004 Belhe et al.
2004/0225301 A1 11/2004 Roop et al.
2004/0243216 A1 12/2004 Gregorich
2004/0249412 A1 12/2004 Snow et al.
2004/0254591 A1 12/2004 Kanner et al.
2004/0267193 A1 12/2004 Bagaoisan et al.
2004/0267308 A1 12/2004 Bagaoisan et al.
2005/0033326 A1 2/2005 Briganti et al.
2005/0038460 A1 2/2005 Jayaraman
2005/0038500 A1 2/2005 Boylan et al.
2005/0059982 A1 3/2005 Zung et al.
2005/0075654 A1 4/2005 Kelleher
2005/0075665 A1 4/2005 Brenzel et al.
2005/0085851 A1 4/2005 Fiehler et al.
2005/0085854 A1 4/2005 Ginn
2005/0085855 A1 4/2005 Forsberg
2005/0119695 A1 6/2005 Carley et al.
2005/0121042 A1 6/2005 Belhe et al.
2005/0148818 A1 7/2005 Mesallum
2005/0149066 A1 7/2005 Stafford
2005/0149117 A1 7/2005 Khosravi et al.
2005/0152949 A1 7/2005 Hotchkiss et al.
2005/0154401 A1 7/2005 Weldon et al.
2005/0165357 A1 7/2005 McGuckin et al.
2005/0169974 A1 8/2005 Tenerz et al.
2005/0177189 A1 8/2005 Ginn et al.
2005/0187564 A1 8/2005 Jayaraman
2005/0203552 A1 9/2005 Laufer et al.
2005/0222614 A1 10/2005 Ginn et al.
2005/0228405 A1 10/2005 Maruyama et al.
2005/0228443 A1 10/2005 Yassinzadeh
2005/0245876 A1 11/2005 Khosravi et al.
2005/0251202 A1 11/2005 Ewers et al.
2005/0256532 A1 11/2005 Nayak et al.
2005/0267495 A1 12/2005 Ginn et al.
2005/0267524 A1 12/2005 Chanduszko
2005/0273136 A1 12/2005 Belef et al.
2005/0273137 A1 12/2005 Ginn
2005/0283188 A1 12/2005 Loshakove et al.
2006/0034930 A1 2/2006 Khosravi et al.
2006/0047313 A1 3/2006 Khanna et al.
2006/0058844 A1 3/2006 White et al.
2006/0064115 A1 3/2006 Allen et al.
2006/0069397 A1 3/2006 Nobles et al.
2006/0089635 A1 4/2006 Young et al.
2006/0095029 A1 5/2006 Young et al.
2006/0100664 A1 5/2006 Pai et al.
2006/0106418 A1 5/2006 Seibold et al.
2006/0142784 A1 6/2006 Kontos
2006/0162509 A1 7/2006 Wang
2006/0190014 A1 8/2006 Ginn et al.
2006/0190036 A1 8/2006 Wendel et al.
2006/0190037 A1 8/2006 Ginn et al.
2006/0195125 A1 8/2006 Sakakine et al.
2006/0217744 A1 9/2006 Bender et al.
2006/0229553 A1 10/2006 Hammack et al.
2006/0253037 A1 11/2006 Ginn et al.
2006/0253072 A1 11/2006 Pai et al.
2006/0259049 A1 11/2006 Harada et al.
2006/0265012 A1 11/2006 Anderson
2006/0287673 A1 12/2006 Brett et al.
2006/0293698 A1 12/2006 Douk
2007/0005093 A1 1/2007 Cox
2007/0010851 A1 1/2007 Chanduszko et al.
2007/0027476 A1 2/2007 Harris et al.
2007/0027525 A1 2/2007 Ben-Muvhar
2007/0049668 A1 3/2007 Garner
2007/0049967 A1 3/2007 Sibbitt et al.
2007/0049968 A1 3/2007 Sibbitt et al.
2007/0049970 A1 3/2007 Belef et al.
2007/0060858 A1 3/2007 Sogard et al.
2007/0060895 A1 3/2007 Sibbitt et al.
2007/0060950 A1 3/2007 Khosravi et al.
2007/0060951 A1 3/2007 Shannon
2007/0073337 A1 3/2007 Abbott et al.
2007/0078302 A1 4/2007 Ortiz et al.
2007/0083230 A1 4/2007 Javois
2007/0083231 A1 4/2007 Lee
2007/0093869 A1 4/2007 Bloom et al.
2007/0112304 A1 5/2007 Voss
2007/0112365 A1 5/2007 Hilal et al.
2007/0112385 A1 5/2007 Conlon
2007/0123816 A1 5/2007 Zhu et al.
2007/0123817 A1 5/2007 Khosravi et al.
2007/0123936 A1 5/2007 Goldin et al.
2007/0149996 A1 6/2007 Coughlin
2007/0167981 A1 7/2007 Opolski et al.
2007/0172430 A1 7/2007 Brito et al.
2007/0179527 A1 8/2007 Eskuri et al.
2007/0185529 A1 8/2007 Coleman et al.
2007/0185530 A1 8/2007 Chin-Chen et al.
2007/0203506 A1 8/2007 Sibbitt et al.
2007/0203507 A1 8/2007 McLaughlin et al.
2007/0208376 A1 9/2007 Meng
2007/0213747 A1 9/2007 Monassevitch et al.
2007/0225755 A1 9/2007 Preinitz et al.
2007/0225756 A1 9/2007 Preinitz et al.
2007/0225757 A1 9/2007 Preinitz et al.
2007/0225758 A1 9/2007 Preinitz et al.
2007/0239209 A1 10/2007 Fallman

(56) **References Cited**

U.S. PATENT DOCUMENTS

2007/0265658 A1 11/2007 Nelson et al.
2007/0275036 A1 11/2007 Green et al.
2007/0276488 A1 11/2007 Wachter et al.
2007/0282373 A1 12/2007 Ashby et al.
2008/0009794 A1 1/2008 Bagaoisan et al.
2008/0033459 A1 2/2008 Shafi et al.
2008/0045979 A1 2/2008 Ma
2008/0058839 A1 3/2008 Nobles et al.
2008/0065151 A1 3/2008 Ginn
2008/0082123 A1 4/2008 Forsberg et al.
2008/0086075 A1 4/2008 Isik et al.
2008/0091235 A1 4/2008 Sirota
2008/0093414 A1 4/2008 Bender et al.
2008/0097509 A1 4/2008 Beyar et al.
2008/0114378 A1 5/2008 Matsushita
2008/0114395 A1 5/2008 Mathisen et al.
2008/0177288 A1 7/2008 Carlson
2008/0208225 A1 8/2008 Seibold et al.
2008/0215089 A1 9/2008 Williams et al.
2008/0215090 A1 9/2008 Gonzales et al.
2008/0243148 A1 10/2008 Mikkaichi et al.
2008/0243182 A1 10/2008 Bates et al.
2008/0249504 A1 10/2008 Attouf et al.
2008/0262541 A1 10/2008 Sater et al.
2008/0269801 A1 10/2008 Coleman et al.
2008/0287967 A1 11/2008 Andreas et al.
2008/0287988 A1 11/2008 Smith et al.
2008/0294001 A1 11/2008 Surti
2008/0300628 A1 12/2008 Ellingwood
2008/0312667 A1 12/2008 Drasler et al.
2008/0312686 A1 12/2008 Ellingwood
2008/0312740 A1 12/2008 Wachter et al.
2009/0054912 A1 2/2009 Heanue et al.
2009/0062846 A1 3/2009 Ken
2009/0105728 A1 4/2009 Noda et al.
2009/0112306 A1 4/2009 Bonsignore et al.
2009/0132031 A1 5/2009 Cook et al.
2009/0137900 A1 5/2009 Bonner et al.
2009/0157101 A1 6/2009 Reyes et al.
2009/0171388 A1 7/2009 Dave et al.
2009/0187215 A1 7/2009 Mackiewicz et al.
2009/0216267 A1 8/2009 Willard et al.
2009/0221960 A1 9/2009 Albrecht et al.
2009/0227938 A1 9/2009 Fasching et al.
2009/0230168 A1 9/2009 Coleman et al.
2009/0254119 A1 10/2009 Sibbitt et al.
2009/0259233 A1 10/2009 Bogart et al.
2009/0281555 A1 11/2009 Stone
2009/0312789 A1 12/2009 Kassab et al.
2010/0042118 A1 2/2010 Garrison et al.
2010/0042144 A1 2/2010 Bennett
2010/0114119 A1 5/2010 Mclawhorn et al.
2010/0130965 A1 5/2010 Sibbitt et al.
2010/0179567 A1 7/2010 Voss et al.
2010/0179589 A1 7/2010 Roorda et al.
2010/0185216 A1 7/2010 Garrison et al.
2010/0185234 A1 7/2010 Fortson et al.
2010/0249828 A1 9/2010 Mavani et al.
2010/0262166 A1 10/2010 Boraiah et al.
2011/0054492 A1 3/2011 Clark
2011/0066163 A1 3/2011 Cho et al.
2011/0082495 A1 4/2011 Ruiz
2011/0137340 A1 6/2011 Cummins
2011/0178548 A1 7/2011 Tenerz
2011/0190793 A1 8/2011 Nobles et al.
2011/0218568 A1 9/2011 Voss
2011/0270282 A1 11/2011 Lemke
2012/0101520 A1 4/2012 Ginn et al.
2012/0245623 A1 9/2012 Kariniemi et al.
2013/0053792 A1 2/2013 Fischell et al.
2013/0165956 A1 6/2013 Sherts et al.
2013/0178872 A1 7/2013 Shriver
2013/0310853 A1 11/2013 Zaugg et al.
2014/0039549 A1 2/2014 Belsky et al.
2014/0081318 A1 3/2014 Houser et al.
2015/0080914 A1 3/2015 Roundy et al.
2015/0190071 A1 7/2015 Ellingwood et al.
2016/0000417 A1 1/2016 Voss
2016/0120546 A1 5/2016 Roundy et al.
2016/0151057 A1 6/2016 Voss
2016/0213357 A1 7/2016 Mehl
2017/0020496 A1 1/2017 Yribarren
2017/0020517 A1 1/2017 Coleman et al.
2018/0256166 A1 9/2018 Cummins et al.
2018/0325506 A1 11/2018 Ellingwood
2019/0117205 A1 4/2019 Kokish
2019/0117207 A1 4/2019 Carley et al.
2019/0350569 A1 11/2019 Palermo et al.
2020/0138423 A1 5/2020 Voss
2020/0138424 A1 5/2020 Gianotti et al.

FOREIGN PATENT DOCUMENTS

CA 2339060 A1 2/2000
DE 19711288 A1 10/1998
DE 29723736 U1 2/1999
DE 19859952 A1 2/2000
DE 102006056283 A1 6/2008
EP 0386361 A1 9/1990
EP 0534696 A1 3/1993
EP 0621032 A1 10/1994
EP 0744237 A1 11/1996
EP 0756851 A2 2/1997
EP 0774237 A2 5/1997
EP 0858776 A2 8/1998
EP 0941697 A1 9/1999
EP 1867287 A2 12/2007
FR 2443238 A1 7/1980
FR 2715290 A1 7/1995
FR 2722975 A1 2/1996
FR 2768324 A1 3/1999
GB 1358466 A 7/1974
GB 2075144 A 11/1981
GB 2397240 A 7/2004
IE 2000/0722 10/2001
IE 2000/0724 10/2001
IE 2001/0547 7/2002
IE 2001/0815 7/2002
IE 2001/0748 8/2002
IE 2001/0749 8/2002
IE 2002/0452 12/2002
IE 2002/0664 2/2003
IE 2002/0665 2/2003
IE 2002/0451 7/2003
IE 2002/0552 7/2003
IE 2003/0424 12/2003
IE 2003/0490 1/2004
IE 2004/0368 11/2005
IE 2005/0342 11/2005
JP 58-181006 U 12/1983
JP 01-274750 A 11/1989
JP 01-275750 A 11/1989
JP 09-218875 A 8/1997
JP 11-500642 A 1/1999
JP 2000-102546 A 4/2000
NL 9302140 A 7/1995
PL 171425 B1 4/1997
RU 2086192 C1 8/1997
SU 0197801 6/1967
SU 0495067 A1 12/1975
SU 0912155 A1 3/1982
SU 1243708 A1 7/1986
SU 1324650 A1 7/1987
SU 1405828 A1 6/1988
SU 1456109 A1 2/1989
SU 1560133 A1 4/1990
WO 95/21573 A1 8/1995
WO 96/24291 A1 8/1996
WO 97/00046 A1 1/1997
WO 97/07741 A1 3/1997
WO 97/20505 A1 6/1997
WO 97/27897 A1 8/1997
WO 97/28745 A1 8/1997
WO 98/06346 A1 2/1998

(56) **References Cited**

FOREIGN PATENT DOCUMENTS

WO	98/06448	A1	2/1998
WO	98/16161	A1	4/1998
WO	98/17179	A1	4/1998
WO	98/18389	A1	5/1998
WO	98/24374	A1	6/1998
WO	98/25508	A2	6/1998
WO	98/58591	A1	12/1998
WO	99/21491	A1	5/1999
WO	99/40849	A1	8/1999
WO	99/60941	A1	12/1999
WO	99/62408	A1	12/1999
WO	99/62415	A1	12/1999
WO	00/06029	A1	2/2000
WO	00/07505	A1	2/2000
WO	00/07640	A2	2/2000
WO	00/27311	A1	5/2000
WO	00/27313	A2	5/2000
WO	00/56223	A1	9/2000
WO	00/56227	A1	9/2000
WO	00/56228	A1	9/2000
WO	00/71032	A2	11/2000
WO	01/21058	A2	3/2001
WO	01/35832	A2	5/2001
WO	01/47594	A1	7/2001
WO	01/49186	A2	7/2001
WO	01/91628	A2	12/2001
WO	02/19915	A1	3/2002
WO	02/19920	A1	3/2002
WO	02/19922	A1	3/2002
WO	02/19924	A1	3/2002
WO	02/28286	A1	4/2002
WO	02/38055	A2	5/2002
WO	02/45593	A2	6/2002
WO	02/45594	A2	6/2002
WO	02/62234	A2	8/2002
WO	02/98302	A1	12/2002
WO	03/13363	A1	2/2003
WO	03/13364	A1	2/2003
WO	03/47434	A1	6/2003
WO	03/71955	A2	9/2003
WO	03/71956	A2	9/2003
WO	03/71957	A2	9/2003
WO	03/94748	A1	11/2003
WO	2003/101310	A1	12/2003
WO	2004/004578	A1	1/2004
WO	2004/012602	A2	2/2004
WO	2004/060169	A2	7/2004
WO	2004/069054	A2	8/2004
WO	2005/000126	A2	1/2005
WO	2005/006990	A2	1/2005
WO	2005/041782	A2	5/2005
WO	2005/063129	A2	7/2005
WO	2005/082256	A1	9/2005
WO	2005/092204	A2	10/2005
WO	2005/110240	A1	11/2005
WO	2005/112782	A1	12/2005
WO	2005/115251	A1	12/2005
WO	2005/115521	A1	12/2005
WO	2006/000514	A1	1/2006
WO	2006/026116	A1	3/2006
WO	2006/052611	A1	5/2006
WO	2006/052612	A1	5/2006
WO	2006/078578	A2	7/2006
WO	2006/083889	A1	8/2006
WO	2006/115901	A1	11/2006
WO	2006/115904	A2	11/2006
WO	2006/118877	A2	11/2006
WO	2007/005585	A2	1/2007
WO	2007/025014	A2	3/2007
WO	2007/025017	A2	3/2007
WO	2007/025018	A2	3/2007
WO	2007/025019	A2	3/2007
WO	2007/081836	A1	7/2007
WO	2007/088069	A1	8/2007
WO	2008/031102	A1	3/2008
WO	2008/036384	A2	3/2008
WO	2008/074027	A1	6/2008
WO	2008/150915	A1	12/2008
WO	2009/079091	A1	6/2009
WO	2010/031050	A1	3/2010
WO	2010/062693	A2	6/2010
WO	2010/081101	A2	7/2010
WO	2010/081102	A2	7/2010
WO	2010/081103	A1	7/2010
WO	2010/081106	A1	7/2010
ZA	200100527		1/2001
ZA	200100528		1/2001

OTHER PUBLICATIONS

Notice of Allowance received for U.S. Appl. No. 09/933,299, mailed on Jun. 16, 2003.
Notice of Allowance received for U.S. Appl. No. 09/948,813, mailed on Jan. 31, 2003.
Notice of Allowance received for U.S. Appl. No. 09/949,398, mailed on Jul. 28, 2003.
Notice of Allowance received for U.S. Appl. No. 09/949,438, mailed on Apr. 21, 2003.
Notice of Allowance received for U.S. Appl. No. 10/006,400, mailed on Apr. 27, 2010.
Notice of Allowance received for U.S. Appl. No. 10/006,400, mailed on Aug. 2, 2010.
Notice of Allowance received for U.S. Appl. No. 10/006,400, mailed on Jan. 13, 2010.
Notice of Allowance received for U.S. Appl. No. 10/006,400, mailed on Jul. 9, 2009.
Notice of Allowance received for U.S. Appl. No. 10/081,717, mailed on Sep. 29, 2003.
Notice of Allowance received for U.S. Appl. No. 10/081,723, mailed on May 13, 2005.
Notice of Allowance received for U.S. Appl. No. 10/081,725, mailed on Feb. 9, 2004.
Notice of Allowance received for U.S. Appl. No. 10/081,726, mailed on Apr. 11, 2003.
Notice of Allowance received for U.S. Appl. No. 10/081,726, mailed on Jun. 9, 2003.
Notice of Allowance received for U.S. Appl. No. 10/147,774, mailed on Apr. 18, 2007.
Notice of Allowance received for U.S. Appl. No. 10/147,774, mailed on Dec. 2, 2010.
Notice of Allowance received for U.S. Appl. No. 10/147,774, mailed on Sep. 27, 2007.
Notice of Allowance received for U.S. Appl. No. 10/240,183, mailed on Mar. 9, 2005.
Notice of Allowance received for U.S. Appl. No. 10/264,306, mailed on Feb. 4, 2008.
Notice of Allowance received for U.S. Appl. No. 10/264,306, mailed on Jul. 2, 2007.
Notice of Allowance received for U.S. Appl. No. 10/264,306, mailed on May 10, 2006.
Notice of Allowance received for U.S. Appl. No. 10/264,306, mailed on Oct. 29, 2010.
Notice of Allowance received for U.S. Appl. No. 10/335,075, mailed on Dec. 27, 2006.
Notice of Allowance received for U.S. Appl. No. 10/356,214, mailed on Jan. 13, 2010.
Notice of Allowance received for U.S. Appl. No. 10/356,214, mailed on May 13, 2010.
Notice of Allowance received for U.S. Appl. No. 10/356,214, mailed on Sep. 3, 2010.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Apr. 4, 2008.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Aug. 2, 2007.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Dec. 22, 2008.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Dec. 28, 2006.

(56) **References Cited**

OTHER PUBLICATIONS

Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Jan. 20, 2010.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Jul. 10, 2007.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Jul. 23, 2009.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Nov. 14, 2007.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Oct. 5, 2010.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Oct. 26, 2007.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Sep. 21, 2004.
Notice of Allowance received for U.S. Appl. No. 10/435,104, mailed on Sep. 26, 2008.
Notice of Allowance received for U.S. Appl. No. 10/455,768, mailed on Apr. 6, 2005.
Notice of Allowance received for U.S. Appl. No. 10/486,067, mailed on Sep. 20, 2006.
Notice of Allowance received for U.S. Appl. No. 10/486,070, mailed on Oct. 18, 2005.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Apr. 23, 2010.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Aug. 3, 2010.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Aug. 13, 2008.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Feb. 10, 2009.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Jan. 11, 2010.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Jun. 26, 2009.
Notice of Allowance received for U.S. Appl. No. 10/517,004, mailed on Mar. 24, 2009.
Notice of Allowance received for U.S. Appl. No. 10/519,778, mailed on May 31, 2006.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on Apr. 16, 2009.
Office Action received for U.S. Appl. No. 13/026,989, filed Aug. 23, 2013.
Office Action received for U.S. Appl. No. 13/026,989, filed Jun. 8, 2012.
Office Action received for U.S. Appl. No. 13/026,989, mailed on Sep. 16, 2011.
Office Action received for U.S. Appl. No. 13/028,041, filed Feb. 26, 2013.
Office Action Received for U.S. Appl. No. 13/028,041, mailed on Jan. 4, 2013.
Office Action received for U.S. Appl. No. 13/030,922, filed Dec. 18, 2012.
Office Action received for U.S. Appl. No. 13/030,922, filed Jan. 31, 2013.
Office Action received for U.S. Appl. No. 13/030,922, filed Jul. 18, 2013.
Office Action received for U.S. Appl. No. 13/039,087, mailed on Jul. 17, 2012.
Office Action received for U.S. Appl. No. 13/112,618, filed Jan. 29, 2016.
Office Action received for U.S. Appl. No. 13/112,618, mailed on Dec. 15, 2014.
Office Action received for U.S. Appl. No. 13/112,618, mailed on Jun. 7, 2013.
Office Action received for U.S. Appl. No. 13/112,618, mailed on Mar. 29, 2013.
Office Action received for U.S. Appl. No. 13/112,618, mailed on May 18, 2015.
Office Action received for U.S. Appl. No. 13/112,618, mailed on Nov. 20, 2013.
Office Action received for U.S. Appl. No. 13/112,631, mailed on Apr. 15, 2015.
Office Action received for U.S. Appl. No. 13/112,631, mailed on Dec. 2, 2013.
Office Action received for U.S. Appl. No. 13/112,631, mailed on Jun. 26, 2013.
Office Action received for U.S. Appl. No. 13/112,631, mailed on Mar. 29, 2013.
Office Action received for U.S. Appl. No. 13/112,631, mailed on Nov. 20, 2014.
Office Action received for U.S. Appl. No. 13/153,594, filed Jan. 29, 2013.
Office Action received for U.S. Appl. No. 13/153,594, filed May 29, 2013.
Office Action received for U.S. Appl. No. 13/222,899, filed Aug. 5, 2015.
Office Action received for U.S. Appl. No. 13/222,899, filed Jan. 10, 2014.
Office Action received for U.S. Appl. No. 13/222,899, mailed on Apr. 1, 2015.
Office Action received for U.S. Appl. No. 13/222,899, mailed on Jul. 31, 2014.
Office Action received for U.S. Appl. No. 13/308,227, filed Jul. 14, 2015.
Office Action received for U.S. Appl. No. 13/308,227, mailed on Apr. 10, 2013.
Office Action received for U.S. Appl. No. 13/308,227, mailed on Sep. 11, 2013.
Office Action received for U.S. Appl. No. 13/490,143, filed on Jan. 4, 2013.
Office Action received for U.S. Appl. No. 13/525,839, filed Apr. 1, 2013.
Office Action received for U.S. Appl. No. 13/615,547, filed Jan. 18, 2013.
Office Action received for U.S. Appl. No. 13/725,589, filed Sep. 17, 2015.
Office Action received for U.S. Appl. No. 13/791,829, filed May 29, 2013.
Office Action received for U.S. Appl. No. 13/791,846, mailed on Jun. 4, 2015.
Office Action received for U.S. Appl. No. 13/837,801, filed Feb. 9, 2017.
Office Action received for U.S. Appl. No. 13/837,801, filed Jul. 6, 2017.
Office Action received for U.S. Appl. No. 13/837,801, filed Jun. 9, 2016.
Office Action received for U.S. Appl. No. 13/837,801, mailed on Dec. 16, 2015.
Office Action received for U.S. Appl. No. 13/898,202, mailed on Aug. 21, 2014.
Office Action received for U.S. Appl. No. 13/898,202, mailed on Jan. 3, 2014.
Office Action received for U.S. Appl. No. 13/908,796, filed Jul. 21, 2015.
Office Action received for U.S. Appl. No. 14/017,039, mailed on Jan. 23, 2015.
Office Action received for U.S. Appl. No. 14/017,039, mailed on Jun. 10, 2015.
Office Action received for U.S. Appl. No. 14/017,039, mailed on Oct. 27, 2015.
Office Action received for U.S. Appl. No. 14/023,428, filed Dec. 20, 2016.
Office Action received for U.S. Appl. No. 14/023,428, filed Feb. 9, 2016.
Office Action received for U.S. Appl. No. 14/023,428, filed Jul. 18, 2017.
Office Action received for U.S. Appl. No. 14/023,428, filed Jul. 27, 2015.
Office Action received for U.S. Appl. No. 14/023,428, filed Jun. 13, 2016.

(56) **References Cited**

OTHER PUBLICATIONS

Office Action received for U.S. Appl. No. 12/122,603, mailed on Nov. 20, 2013.
Office Action received for U.S. Appl. No. 12/122,603, mailed on Sep. 23, 2011.
Office Action received for U.S. Appl. No. 12/135,858, filed Feb. 16, 2012.
Office Action received for U.S. Appl. No. 12/135,858, filed Jul. 13, 2011.
Office Action received for U.S. Appl. No. 12/143,020, mailed on Aug. 31, 2011.
Office Action received for U.S. Appl. No. 12/143,020, mailed on May 11, 2011.
Office Action received for U.S. Appl. No. 12/338,977, filed Jun. 19, 2013.
Office Action received for U.S. Appl. No. 12/338,977, filed Nov. 28, 2012.
Office Action received for U.S. Appl. No. 12/338,977, mailed on Jan. 19, 2012.
Office Action received for U.S. Appl. No. 12/338,977, mailed on Jul. 11, 2012.
Office Action received for U.S. Appl. No. 12/365,397, mailed on Sep. 13, 2010.
Office Action received for U.S. Appl. No. 12/393,877, filed Dec. 13, 2011.
Office Action received for U.S. Appl. No. 12/393,877, filed May 21, 2012.
Office Action received for U.S. Appl. No. 12/393,877, mailed on Sep. 29, 2011.
Office Action received for U.S. Appl. No. 12/402,398, mailed on Jan. 24, 2011.
Office Action received for U.S. Appl. No. 12/402,398, mailed on Mar. 9, 2010.
Office Action received for U.S. Appl. No. 12/402,398, mailed on May 20, 2010.
Office Action received for U.S. Appl. No. 12/402,398, mailed on Sep. 20, 2012.
Office Action received for U.S. Appl. No. 12/403,256, mailed on Dec. 16, 2009.
Office Action received for U.S. Appl. No. 12/403,256, mailed on Mar. 30, 2010.
Office Action received for U.S. Appl. No. 12/403,277, filed Nov. 5, 2012.
Office Action received for U.S. Appl. No. 12/403,277, mailed on Apr. 3, 2012.
Office Action received for U.S. Appl. No. 12/403,277, mailed on Aug. 15, 2014.
Office Action received for U.S. Appl. No. 12/403,277, mailed on Jan. 27, 2014.
Office Action received for U.S. Appl. No. 12/403,277, mailed on Jul. 8, 2010.
Office Action received for U.S. Appl. No. 12/403,277, mailed on Mar. 31, 2011.
Office Action received for U.S. Appl. No. 12/403,277, mailed on Oct. 12, 2010.
Office Action received for U.S. Appl. No. 12/481,377, filed Jan. 3, 2012.
Office Action received for U.S. Appl. No. 12/481,377, mailed on Apr. 28, 2011.
Office Action received for U.S. Appl. No. 12/481,377, mailed on Jun. 21, 2011.
Office Action received for U.S. Appl. No. 12/548,274, filed Aug. 14, 2014.
Office Action received for U.S. Appl. No. 12/548,274, filed Sep. 10, 2012.
Office Action received for U.S. Appl. No. 12/548,274, mailed on Dec. 28, 2011.
Office Action received for U.S. Appl. No. 12/548,274, mailed on Mar. 2, 2012.
Office Action received for U.S. Appl. No. 12/608,769, filed Feb. 10, 2012.
Office Action received for U.S. Appl. No. 12/608,769, mailed on Aug. 22, 2012.
Office Action received for U.S. Appl. No. 12/608,773, filed Jul. 17, 2014.
Office Action received for U.S. Appl. No. 12/608,773, filed Jul. 20, 2012.
Office Action received for U.S. Appl. No. 12/608,773, filed Jun. 7, 2012.
Office Action received for U.S. Appl. No. 12/608,773, filed Mar. 12, 2015.
Office Action received for U.S. Appl. No. 12/608,773, mailed on Jan. 7, 2013.
Office Action received for U.S. Appl. No. 12/642,319, filed Aug. 28, 2012.
Office Action received for U.S. Appl. No. 12/642,319, filed Feb. 27, 2012.
Office Action received for U.S. Appl. No. 12/642,319, mailed on Dec. 16, 2013.
Office Action received for U.S. Appl. No. 12/684,400, filed Feb. 13, 2012.
Office Action received for U.S. Appl. No. 12/684,400, filed Feb. 23, 2015.
Office Action received for U.S. Appl. No. 12/684,400, filed May 9, 2012.
Office Action received for U.S. Appl. No. 12/684,400, filed Oct. 16, 2012.
Office Action received for U.S. Appl. No. 12/684,470, filed Aug. 26, 2015.
Office Action received for U.S. Appl. No. 12/684,470, filed Aug. 30, 2012.
U.S. Appl. No. 11/508,662, filed Oct. 26, 2010, Office Action.
U.S. Appl. No. 11/891,358, filed Apr. 26, 2010, Office Action.
U.S. Appl. No. 12/684,470, filed Jan. 21, 2016, Office Action.
U.S. Appl. No. 12/684,470, filed Jun. 4, 2014, Office Action.
U.S. Appl. No. 12/684,470, Mail Date Aug. 26, 2015, Office Action.
U.S. Appl. No. 13/052,634, filed Apr. 22, 2013, Office Action.
U.S. Appl. No. 13/052,634, filed Feb. 8, 2013, Office Action.
U.S. Appl. No. 13/052,634, filed Nov. 8, 2013, Office Action.
U.S. Appl. No. 13/308,227, filed Dec. 2, 2013, Interview Summary.
U.S. Appl. No. 13/615,547, filed Apr. 12, 2013, Notice of Allowance.
U.S. Appl. No. 29/230,479, Notices of Allowance, Mail Date Aug. 24, 2006.
U.S. Application Filed on Apr. 30, 2008, by Ginn et al., U.S. Appl. No. 12/113,092.
U.S. Application Filed on Jan. 31, 2011, by Carley et al., U.S. Appl. No. 13/017,636.
U.S. Patent Application filed Apr. 18, 2016, by Roorda et al., U.S. Appl. No. 15/131,786.
U.S. Provisional Application filed Apr. 20, 2006, by Jones et al., U.S. Appl. No. 60/793,444.
U.S. Provisional Application filed Aug. 24, 2005, by Sibbitt Jr et al., U.S. Appl. No. 60/711,279.
U.S. Provisional Application filed Dec. 19, 2007, by Mackiewicz et al., U.S. Appl. No. 61/015,144.
U.S. Provisional Application filed Dec. 22, 2008, by Clark, U.S. Appl. No. 61/139,995.
U.S. Provisional Application filed Dec. 30, 2008, by Clark, U.S. Appl. No. 61/141,597.
U.S. Provisional Application filed Jan. 9, 2009, by Mehl et al., U.S. Appl. No. 61/143,748.
U.S. Provisional Application filed Jan. 9, 2009, by Voss et al., U.S. Appl. No. 61/143,751.
U.S. Provisional Application filed Jan. 16, 2009, by Fortson, et al., U.S. Appl. No. 61/145,468.
U.S. Provisional Application filed Jul. 1, 2005, by Pantages et al., U.S. Appl. No. 60/696,069.
U.S. Provisional Application filed Jun. 24, 2005, by Carly, U.S. Appl. No. 60/693,531.
U.S. Provisional Application filed Jun. 25, 2007, by Ellingwood et al., U.S. Appl. No. 60/946,042.

(56) **References Cited**

OTHER PUBLICATIONS

U.S. Provisional Application filed Jun. 25, 2007, by Ellingwood, U.S. Appl. No. 60/946,026.
U.S. Provisional Application filed Jun. 25, 2007, by Voss et al., U.S. Appl. No. 60/946,030.
U.S. Provisional Application filed May 25, 2001 by Ginn., U.S. Appl. No. 09/866,551.
U.S. Provisional Application filed Oct. 14, 2005, by Sibbitt Jr. et al., U.S. Appl. No. 60/726,985.
U.S. Provisional Application filed Oct. 30, 2008, by Mehl et al., U.S. Appl. No. 61/109,822.
U.S. Provisional Application filed Sep. 15, 2008, by Sibbitt Jr. et al., U.S. Appl. No. 61/097,072.
Ut Aker et al., Immediate arterial hemostasis after cardiac catheterization: initial experience with a new puncture closure device, Cathet Cardiovasc Diagn, Mar. 1994, pp. 228-232, vol. 33—No. 3, Missouri Baptist Medical Center, St. Louis.
Watelet et al., Percutaneous repair of aortic aneurysms: a prospective study of suture-mediated closure devices, European journal of vascular and endovascular surgery, vol. 32, No. 3, 2006, p. 261-265.
Wei Qu et al., An absorbable pinned-ring device for microvascular anastomosis of vein grafts: Experimental studies, Microsurgery 1999, Mar. 1999, pp. 128-134, vol. 19—No. 3, Department of Orthopaedic Surgery, Hiroshima University School of Medicine, Hiroshima, Japan.
William G. Kussmaul III MD, et al., Rapid arterial hemostasis and decreased access site complications after cardiac catheterization and angioplasty: Results of a randomized trial of a novel hemostatic device, Journal of the American College of Cardiology, Jun. 1995, pp. 1685-1692, vol. 25—No. 7.
Office Action received for U.S. Appl. No. 11/396,141, mailed on Aug. 21, 2013.
Office Action received for U.S. Appl. No. 11/427,297, mailed on Sep. 15, 2010.
Office Action received for U.S. Appl. No. 13/111,371, mailed on Oct. 12, 2012.
OM Elashry et al., Comparative clinical study of port-closure techniques following laparoscopic surgery, Department of Surgery, Mallickrodt Institute of Radiography, J Am Coll Surg., Oct. 1996, pp. 335-344, vol. 183—No. 4.
P M N Werker, et al., Review of facilitated approaches to vascular anastomosis surgery towards minimally invasive coronary artery bypass grafting, Conference: Utrecht MICABG Workshop 2, The Annals of thoracic surgery, Apr. 1996, pp. 122-127, vol. 63—No. 6, Department of Plastic, Reconstructive and Hand surgery, University Hospital Utrecht Netherlands Departments of Cardiology and Cardiopulmonary Surgery, Heart Lung Institute, Utrecht Netherlands.; Utrect University Hospital Utrecht Netherlands.
PCT patent application No. PCT/US2006/024334, Written Opinion mailed Jan. 16, 2007.
PCT Publication No. WO 00/56223 entitled "Vascular Closure Device", Sep. 28, 2000.
Peter Rhee MD et al., Use of Titanium Vascular Staples in Trauma, Journal of Trauma-Injury Infection & Critical Care, Dec. 1998, pp. 1097-1099, vol. 45—No. 6, Institution from the Department of Surgery, Washington Hospital Center, Washington DC, and Uniformed Services University of the Health Sciences, Bethesda, Maryland.
ProstarXL—Percutaneous Vascular Surgical Device, www.Archive.org, Jun. 1998, Original Publisher: http://prostar.com, may also be found at http://web.archive.org/web/19980630040429/www.perclose.com/html/prstrxl.html.
Rachel et al., Percutaneous endovascular abdominal aortic aneurysm repair, Annals of vascular surgery, vol. 16, No. 1, 2002, p. 43-49.
Restriction Requirement received for U.S. Appl. No. 10/638,115, mailed on Sep. 22, 2006.
Sa Beyer-Enke et al., Immediate sealing of arterial puncture site following femoropopliteal angioplasty: A prospective randomized trial, Cardiovascular And Interventional Radiology 1996, Nov-Dec. 1996, pp. 406-410, vol. 19—No. 6, Gen Hosp North, Dept Dianost & Intervent Radial, Nurnberg, Germany (Reprint).
Scott Hensley, Closing Wounds. New Devices seal arterial punctures in double time, Modern Healthcare (United States), Mar. 23, 2008, p. 48.
Serruys, PW et al., A Comparision Of Balloon-Expandable-Stent Implantaion With Balloon Angioplast In Patients With Coronary Artery Disease, New England Journal of Medicine, 331:489-495, 1994.
Sigmund Silber et al., A novel vascular device for closure of percutaneous arterial access sites, The American Journal of Cardiology, Apr. 1999, pp. 1248-1252, vol. 83—No. 8.
Simonetta Blengino et al., A Randomized Study of the 8 French Hemostatic Puncture Closure Device vs Manual Compression After Coronary Interventions, Journal of the American College of Cardiology, Feb. 1995, p. 262A, vol. 25.—No. 2, Supplement 1.
Starnes et al., Totally percutaneous aortic aneurysm repair: experience and prudence, Journal of vascular surgery, vol. 43, No. 2, 2006, p. 270-276.
Stretch Comb by Scunci, retrieved via internet at www.scunci.com/productdetail on Oct. 9, 2007, publication date unavailable.
Swee Lian Tan, MD, PhD, FAGS, Explanation of Infected Hemostatic Puncture Closure Devices—A Case Report, Vascular and Endovascular Surgery, 1999, pp. 507-510, vol. 33—No. 5, Parkland Medical Center, Derry, New Hampshire.
Sy Nakada et al., Comparison of newer laparoscopic port closure techniques in the porcine model, J Endourol, Oct. 1995, pp. 397-401, vol. 9—No. 5, Department of Surgery/Urology, University of Wisconsin Medical School, Madison.
Taber's Cyclopedic Medical Dictionary, 18.sup.th Ed. 1997, pp. 747 and 1420.
Teh et al., Use of the percutaneous vascular surgery device for closure of femoral access sites during endovascular aneurysm repair: lessons from our experience, European Journal of Vascular and Endovascular Surgery, vol. 22, No. 5, 2001, p. 418-423.
Thomas P. Baum Rpa-C et al., Delayed Primary Closure Using Silastic Vessel Loops and Skin Staples: Description of the Technique and Case Reports, Annals of Plastic Surgery, Mar. 1999, pp. 337-340, vol. 42—No. 3, Institution Department of Plastic and Reconstructive Surgery, Albert Einstein College of Medicine and Montefiore Medical Center, Bronx, NY.
Tomoaki Hinohara, Percutaneous vascular surgery (Prostar® Plus and Techstar® for femoral artery site closure), Interventional Cardiology Newsletter, May-Jul. 1997, pp. 19-22, pp. 24-28, vol. 5—No. 3-4.
Torsello et al., Endovascular suture versus cutdown for endovascular aneurysm repair: a prospective randomized pilot study, Journal of vascular surgery, vol. 38, No. 1, 2003, p. 78-82.
Traul et al., Percutaneous endovascular repair of infrarenal abdominal aortic aneurysms: a feasibility study, Journal of vascular surgery, vol. 32, No. 4, 2000, p. 770-776.
Turn—macmillandictionary.com/dictionary.american/turn.
U.S. Appl. filed Dec. 30, 2008, Clark., U.S. Appl. No. 61/481,377.
U.S. Appl. filed Jan. 21, 2011, Von Oepen et al., U.S. Appl. No. 13/011,850.
U.S. Appl. filed Jul. 1, 2005, Pantages et al., U.S. Appl. No. 60/696,096.
U.S. Appl. filed Jul. 5, 2000, Kerievsky., U.S. Appl. No. 09/610,128.
U.S. Appl. filed Jun. 18, 2012, Carley et al., U.S. Appl. No. 13/525,718.
U.S. Appl. filed Oct. 4, 2010, Carley., U.S. Appl. No. 12/987,358.
U.S. Appl. No. 10/027,681, filed Jul. 8, 2009, Office Action.
U.S. Appl. No. 10/081,725, Mail Date Feb. 9, 2004, Notice of Allowance.
U.S. Appl. No. 10/240, 183, Aug. 11, 2006, Response to 312 Amendment.
U.S. Appl. No. 10/264,306, mailed May 26, 2005, Office Action.
U.S. Appl. No. 10/305,923, mail date Mar. 3, 2005, Notice Of Allowance.
U.S. Appl. No. 10/305,923, mail date Nov. 1, 2004, Office Action.
U.S. Appl. No. 10/787,073, filed Nov. 30, 2006, Office Action.
U.S. Appl. No. 11/316,775, filed Aug. 6, 2008, Office Action.
U.S. Appl. No. 11/461,323, filed Jul. 27, 2009, Office Action.

(56) **References Cited**

OTHER PUBLICATIONS

U.S. Appl. No. 11/461,323, Mail Date Apr. 25, 2008, Office Action.
U.S. Appl. No. 11/461,323, mail date Apr. 5, 2010, Notice Of Allowance.
U.S. Appl. No. 11/461,323, mail date May 2, 2007, Office Action.
U.S. Appl. No. 11/461,323, mailed Nov. 6, 2008, Office Action.
U.S. Appl. No. 11/461,323, mailed Oct. 29, 2007, Office Action.
U.S. Appl. No. 11/508,656, filed Aug. 30, 2010, Office Action.
U.S. Appl. No. 11/508,656, mail date Mar. 25, 2010, Office Action.
U.S. Appl. No. 11/508,662, mail date Apr. 14, 2010, Office Action.
Office Action received for U.S. Appl. No. 12/684,470, filed Dec. 20, 2011.
Office Action received for U.S. Appl. No. 12/684,470, mailed on Jan. 21, 2016.
Office Action received for U.S. Appl. No. 12/684,470, mailed on Jun. 4, 2014.
Office Action received for U.S. Appl. No. 12/684,470, mailed on Mar. 23, 2012.
Office Action received for U.S. Appl. No. 12/684,470, mailed on Nov. 14, 2014.
Office Action received for U.S. Appl. No. 12/684,542, filed Dec. 1, 2014.
Office Action received for U.S. Appl. No. 12/684,542, filed Jun. 18, 2014.
Office Action received for U.S. Appl. No. 12/684,542, mailed on Apr. 16, 2012.
Office Action received for U.S. Appl. No. 12/684,542, mailed on Jan. 30, 2012.
Office Action received for U.S. Appl. No. 12/684,542, mailed on Sep. 13, 2012.
Office Action received for U.S. Appl. No. 12/684,562, filed Dec. 28, 2011.
Office Action received for U.S. Appl. No. 12/684,562, filed Feb. 16, 2012.
Office Action received for U.S. Appl. No. 12/684,562, mailed on Aug. 21, 2012.
Office Action received for U.S. Appl. No. 12/684,562, mailed on Sep. 10, 2014.
Office Action received for U.S. Appl. No. 12/684,569, filed Apr. 23, 2014.
Office Action received for U.S. Appl. No. 12/684,569, filed Dec. 20, 2011.
Office Action received for U.S. Appl. No. 12/684,569, filed Jan. 27, 2012.
Office Action received for U.S. Appl. No. 12/684,569, filed Jul. 30, 2012.
Office Action received for U.S. Appl. No. 12/688,065, filed Apr. 26, 2012.
Office Action received for U.S. Appl. No. 12/688,065, filed Mar. 13, 2012.
Office Action received for U.S. Appl. No. 12/688,065, filed Oct. 12, 2012.
Office Action received for U.S. Appl. No. 12/688,065, filed Oct. 18, 2013.
Office Action received for U.S. Appl. No. 12/688,065, mailed on Apr. 8, 2014.
Office Action received for U.S. Appl. No. 12/724,304, filed Feb. 10, 2012.
Office Action received for U.S. Appl. No. 12/848,642, filed Apr. 26, 2013.
Office Action received for U.S. Appl. No. 12/848,642, filed Nov. 9, 2012.
Office Action received for U.S. Appl. No. 12/848,642, filed Sep. 20, 2012.
Office Action received for U.S. Appl. No. 12/850,242, mailed on Apr. 18, 2013.
Office Action received for U.S. Appl. No. 12/850,242, mailed on Aug. 6, 2012.
Office Action received for U.S. Appl. No. 12/850,242, mailed on Oct. 17, 2012.
Office Action received for U.S. Appl. No. 12/897,358, filed Aug. 22, 2011.
Office Action received for U.S. Appl. No. 12/941,809, mailed on Dec. 13, 2011.
Office Action received for U.S. Appl. No. 12/941,809, mailed on Jan. 30, 2012.
Office Action received for U.S. Appl. No. 12/941,809, mailed on Jul. 3, 2013.
Office Action received for U.S. Appl. No. 12/941,809, mailed on Jun. 1, 2012.
Office Action received for U.S. Appl. No. 12/941,809, mailed on Nov. 8, 2013.
Office Action received for U.S. Appl. No. 12/945,646, filed Jul. 6, 2011.
Office Action received for U.S. Appl. No. 12/945,646, mailed on Jan. 20, 2011.
Office Action received for U.S. Appl. No. 12/945,646, mailed on Oct. 26, 2011.
Office Action received for U.S. Appl. No. 12/955,859, filed Dec. 15, 2011.
Office Action received for U.S. Appl. No. 12/955,859, filed Jul. 21, 2011.
Office Action received for U.S. Appl. No. 12/955,859, filed May 26, 2011.
Office Action received for U.S. Appl. No. 12/955,859, mailed on Aug. 6, 2012.
Office Action received for U.S. Appl. No. 12/961,331, filed Feb. 1, 2013.
Office Action received for U.S. Appl. No. 12/961,331, filed Jul. 3, 2013.
Office Action received for U.S. Appl. No. 12/961,331, mailed on Dec. 4, 2012.
Office Action received for U.S. Appl. No. 12/987,792, filed Jun. 11, 2014.
Office Action received for U.S. Appl. No. 12/987,792, filed Mar. 13, 2012.
Office Action received for U.S. Appl. No. 12/987,792, filed Sep. 17, 2012.
Office Action received for U.S. Appl. No. 12/987,792, mailed on Jan. 21, 2014.
Office Action received for U.S. Appl. No. 11/396,141, filed on Apr. 30, 2013.
Office Action received for U.S. Appl. No. 11/396,141, mailed on Aug. 26, 2009.
Office Action received for U.S. U.S. Appl. 11/396,141, mailed on May 4, 2010.
Office Action received for U.S. Appl. No. 11/396,141, mailed on May 22, 2009.
Office Action received for U.S. Appl. No. 11/396,731, filed Feb. 12, 2015.
Office Action received for U.S. Appl. No. 11/396,731, filed Feb. 13, 2009.
Office Action received for U.S. Appl. No. 11/396,731, filed Jun. 29, 2010.
Office Action received for U.S. Appl. No. 11/396,731, filed Mar. 22, 2011.
Office Action received for U.S. Appl. No. 11/396,731, mailed on May 22, 2009.
Office Action received for U.S. Appl. No. 11/396,731, mailed on Sep. 1, 2011.
Office Action received for U.S. Appl. No. 11/406,203, mailed on Mar. 3, 2009.
Office Action received for U.S. Appl. No. 11/406,203, mailed on May 14, 2007.
Office Action received for U.S. Appl. No. 11/406,203, mailed on Sep. 16, 2009.
Office Action received for U.S. Appl. No. 11/411,925, filed Feb. 5, 2008.
Office Action received for U.S. Appl. No. 11/411,925, mailed on Jan. 12, 2009.
Office Action received for U.S. Appl. No. 11/411,925, mailed on Jun. 6, 2007.

(56) **References Cited**

OTHER PUBLICATIONS

Office Action received for U.S. Appl. No. 11/411,925, mailed on Oct. 1, 2013.
Office Action received for U.S. Appl. No. 11/411,925, mailed on Sep. 10, 2009.
Office Action received for U.S. Appl. No. 11/427,297, mailed on Jan. 30, 2009.
Office Action received for U.S. Appl. No. 11/427,297, mailed on Mar. 21, 2011.
Office Action received for U.S. Appl. No. 11/427,297, mailed on Sep. 15, 2009.
Office Action received for U.S. Appl. No. 11/427,309, mailed on Apr. 20, 2009.
Office Action received for U.S. Appl. No. 11/427,309, mailed on Apr. 26, 2010.
Office Action received for U.S. Appl. No. 11/427,309, mailed on Jan. 2, 2009.
Office Action received for U.S. Appl. No. 11/427,309, mailed on May 28, 2008.
Office Action received for U.S. Appl. No. 11/427,309, mailed on Nov. 6, 2009.
Office Action received for U.S. Appl. No. 11/427,309, mailed on Nov. 15, 2010.
Office Action received for U.S. Appl. No. 11/455,993, filed Dec. 16, 2009.
Office Action received for U.S. Appl. No. 11/455,993, mailed on Feb. 17, 2009.
Office Action received for U.S. Appl. No. 11/455,993, mailed on Jan. 29, 2014.
Office Action received for U.S. Appl. No. 11/508,715, mailed on Apr. 26, 2010.
Office Action received for U.S. Appl. No. 11/508,715, mailed on Jan. 6, 2010.
Office Action received for U.S. Appl. No. 11/508,715, mailed on Oct. 18, 2010.
Office Action received for U.S. Appl. No. 11/532,325, filed Jul. 17, 2013.
Office Action received for U.S. Appl. No. 11/532,325, mailed on Dec. 2, 2013.
Office Action received for U.S. Appl. No. 11/532,325, mailed on Feb. 23, 2009.
Office Action received for U.S. Appl. No. 11/532,325, mailed on Jan. 5, 2010.
Office Action received for U.S. Appl. No. 11/532,325, mailed on Jun. 17, 2009.
Office Action received for U.S. Appl. No. 11/532,576, mailed on Apr. 23, 2010.
Office Action received for U.S. Appl. No. 11/532,576, mailed on Mar. 1, 2010.
Office Action received for U.S. Appl. No. 11/674,930, filed Jan. 8, 2010.
Office Action received for U.S. Appl. No. 11/674,930, mailed on Jan. 8, 2010.
Office Action received for U.S. Appl. No. 11/674,930, mailed on Jun. 4, 2009.
Office Action received for U.S. Appl. No. 11/675,462, filed Aug. 3, 2011.
Office Action received for U.S. Appl. No. 11/675,462, filed Aug. 31, 2010.
Office Action received for U.S. Appl. No. 11/675,462, filed Dec. 10, 2009.
Office Action received for U.S. Appl. No. 11/744,089, filed Apr. 15, 2013.
Office Action received for U.S. Appl. No. 11/744,089, filed Aug. 8, 2012.
Office Action received for U.S. Appl. No. 11/744,089, filed Aug. 14, 2009.
Office Action received for U.S. Appl. No. 11/744,089, mailed on Nov. 26, 2008.
Office Action received for U.S. Appl. No. 11/757, 108, mailed on Nov. 25, 2009.
Office Action received for U.S. Appl. No. 11/767,818, mailed on Dec. 24, 2009.
Office Action received for U.S. Appl. No. 11/767,818, mailed on Feb. 16, 2011.
Office Action received for U.S. Appl. No. 11/767,818, mailed on Mar. 22, 2010.
Office Action received for U.S. Appl. No. 11/767,818, mailed on Sep. 30, 2010.
Office Action received for U.S. Appl. No. 11/852,190, filed on Apr. 24, 2013.
Office Action received for U.S. Appl. No. 11/852,190, mailed on Jun. 24, 2010.
Office Action received for U.S. Appl. No. 11/852,190, mailed on Mar. 2, 2011.
Office Action received for U.S. Appl. No. 11/852,190, mailed on Nov. 1, 2010.
Office Action received for U.S. Appl. No. 11/852,190, mailed on Nov. 26, 2013.
Office Action received for U.S. Appl. No. 11/958,281, filed Oct. 8, 2010.
Office Action received for U.S. Appl. No. 11/958,281, filed Sep. 2, 2010.
Office Action received for U.S. Appl. No. 11/958,281, mailed on Mar. 10, 2011.
Office Action received for U.S. Appl. No. 11/958,295, mailed on Aug. 27, 2009.
Office Action received for U.S. Appl. No. 11/958,295, mailed on May 25, 2010.
Office Action received for U.S. Appl. No. 11/959,334, filed Aug. 19, 2009.
Office Action received for U.S. Appl. No. 12/106,928, filed Jan. 23, 2009.
Office Action received for U.S. Appl. No. 12/106,928, filed Oct. 25, 2010.
Office Action received for U.S. Appl. No. 12/106,928, mailed on Dec. 2, 2013.
Office Action received for U.S. Appl. No. 12/106,928, mailed on Jun. 28, 2013.
Office Action received for U.S. Appl. No. 12/106,928, mailed on May 10, 2010.
Office Action received for U.S. Appl. No. 12/106,928, mailed on Oct. 5, 2009.
Office Action received for U.S. Appl. No. 12/106,937, mailed on Jan. 22, 2014.
Office Action received for U.S. Appl. No. 12/106,937, mailed on Jun. 28, 2013.
Office Action received for U.S. Appl. No. 12/106,937, mailed on Mar. 30, 2009.
Office Action received for U.S. Appl. No. 12/106,937, mailed on Nov. 18, 2009.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Apr. 27, 2010.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Apr. 27, 2011.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Aug. 21, 2014.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Dec. 16, 2010.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Jun. 24, 2010.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Mar. 17, 2014.
Office Action received for U.S. Appl. No. 12/113,851, mailed on Mar. 29, 2012.
Office Action received for U.S. Appl. No. 12/114,031, filed May 11, 2011.
Office Action received for U.S. Appl. No. 12/114,031, mailed on Aug. 2, 2011.
Office Action received for U.S. Appl. No. 12/114,031, mailed on Mar. 6, 2012.

(56) **References Cited**

OTHER PUBLICATIONS

Office Action received for U.S. Appl. No. 12/114,031, mailed on Mar. 10, 2014.
Office Action received for U.S. Appl. No. 12/114,031, mailed on Nov. 22, 2010.
Office Action received for U.S. Appl. No. 12/114,031, mailed on Oct. 5, 2010.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Apr. 5, 2012.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Dec. 17, 2010.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Feb. 12, 2015.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Jul. 7, 2011.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Jul. 23, 2015.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Nov. 8, 2012.
Office Action received for U.S. Appl. No. 12/114,091, mailed on Oct. 27, 2010.
Office Action received for U.S. Appl. No. 12/122,603, filed Apr. 22, 2011.
Office Action received for U.S. Appl. No. 12/122,603, filed Apr. 30, 2014.
Office Action received for U.S. Appl. No. 12/122,603, mailed on Apr. 9, 2015.
Office Action received for U.S. Appl. No. 12/122,603, mailed on Mar. 3, 2011.
Notice of Allowance received for U.S. Appl. No. 14/246,973, filed Nov. 9, 2016.
Notice of Allowance received for U.S. Appl. No. 14/312,339, mailed on Jul. 19, 2018.
Notice of Allowance received for U.S. Appl. No. 14/323,753, filed Apr. 15, 2016.
Notice of Allowance received for U.S. Appl. No. 14/466,576, filed Dec. 15, 2015.
Notice of Allowance received for U.S. Appl. No. 14/539,830, filed Nov. 18, 2016.
Notice of Allowance received for U.S. Appl. No. 14/732,977, filed May 29, 2018.
Notice of Allowance received for U.S. Appl. No. 14/839,658, filed Feb. 28, 2018.
Notice of Allowance received for U.S. Appl. No. 15/056,281, filed Apr. 17, 2019.
Notice of Allowance received for U.S. Appl. No. 15/069,230, filed Jun. 19, 2019.
Notice of Allowance received for U.S. Appl. No. 15/142,106, mailed on Sep. 25, 2019.
Notice of Allowance received for U.S. Appl. No. 15/344,978, mailed on Sep. 25, 2019.
Notice of Allowance received for U.S. Appl. No. 15/356,028, filed Nov. 20, 2018.
Notice of Allowance received for U.S. Appl. No. 15/419,335, filed Nov. 30, 2018.
Notice of Allowance received for U.S. Appl. No. 29/296,370, mailed on Apr. 1, 2009.
Notice of Allowance received for U.S. Appl. No. 29/296,370, mailed on Dec. 2, 2008.
Notice of Allowance received for U.S. Appl. No. 10/147,774, mailed on Feb. 4, 2008.
Notice of Allowance received for U.S. Appl. No. 11/532,576, mailed on Oct. 13, 2010.
Notice of Allowance received for U.S. Appl. No. 13/615,547, mailed on Apr. 12, 2013.
Office Action received for U.S. Appl. No. 09/610,238, mailed on Sep. 5, 2001.
Office Action received for U.S. Appl. No. 09/680,837, mailed on Jul. 9, 2002.
Office Action received for U.S. Appl. No. 09/680,837, mailed on Mar. 25, 2003.
Office Action received for U.S. Appl. No. 09/680,837, mailed on Nov. 6, 2002.
Office Action received for U.S. Appl. No. 09/732,178, mailed on Aug. 1, 2002.
Office Action received for U.S. Appl. No. 09/732,178, mailed on Dec. 24, 2002.
Office Action received for U.S. Appl. No. 09/732,178, mailed on Jul. 3, 2003.
Office Action received for U.S. Appl. No. 09/732,835, mailed on Feb. 9, 2004.
Office Action received for U.S. Appl. No. 09/732,835, mailed on Sep. 11, 2003.
Office Action received for U.S. Appl. No. 09/764,813, mailed on Mar. 26, 2001.
Office Action received for U.S. Appl. No. 09/933,299, mailed on Feb. 26, 2003.
Office Action received for U.S. Appl. No. 09/949,398, mailed on Mar. 4, 2003.
Office Action received for U.S. Appl. No. 09/949,438, mailed on Dec. 17, 2002.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Apr. 2, 2008.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Apr. 11, 2005.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Apr. 19, 2007.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Aug. 27, 2004.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Feb. 23, 2005.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Jan. 2, 2009.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Jul. 27, 2005.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Mar. 6, 2006.
Office Action received for U.S. Appl. No. 10/006,400, mailed on May 24, 2006.
Office Action received for U.S. Appl. No. 10/006,400, mailed on Oct. 26, 2006.
Office Action received for U.S. Appl. No. 10/081,723, mailed on Sep. 29, 2004.
Office Action received for U.S. Appl. No. 10/081,725, mailed on Apr. 13, 2004.
Office Action received for U.S. Appl. No. 10/147,774, mailed on Jun. 8, 2010.
Office Action received for U.S. Appl. No. 10/147,774, mailed on Jun. 30, 2008.
Office Action received for U.S. Appl. No. 10/147,774, mailed on Mar. 18, 2009.
Office Action received for U.S. Appl. No. 10/147,774, mailed on May 4, 2005.
Office Action received for U.S. Appl. No. 10/147,774, mailed on Nov. 4, 2004.
Office Action received for U.S. Appl. No. 10/147,774, mailed on Oct. 18, 2005.
Office Action received for U.S. Appl. No. 10/147,774, mailed on Oct. 26, 2009.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on Aug. 17, 2010.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on Dec. 29, 2008.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on Feb. 5, 2010.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on May 10, 2010.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on Sep. 19, 2008.
Notice of Allowance received for U.S. Appl. No. 10/541,083, mailed on Sep. 30, 2009.

(56) **References Cited**

OTHER PUBLICATIONS

Notice of Allowance received for U.S. Appl. No. 10/616,832, mailed on Jan. 11, 2010.
Notice of Allowance received for U.S. Appl. No. 10/616,832, mailed on May 12, 2010.
Notice of Allowance received for U.S. Appl. No. 10/616,832, mailed on Sep. 20, 2010.
Notice of Allowance received for U.S. Appl. No. 10/617,090, mailed on Jul. 6, 2005.
Notice of Allowance received for U.S. Appl. No. 10/617,090, mailed on Oct. 5, 2005.
Notice of Allowance received for U.S. Appl. No. 10/638,115, mailed on Apr. 2, 2010.
Notice of Allowance received for U.S. Appl. No. 10/638,115, mailed on Aug. 13, 2010.
Notice of Allowance received for U.S. Appl. No. 10/638,115, mailed on Dec. 1, 2009.
Notice of Allowance received for U.S. Appl. No. 10/638, 115, mailed on May 7, 2009.
Notice of Allowance received for U.S. Appl. No. 10/667,144, mailed on Oct. 28, 2011.
Notice of Allowance received for U.S. Appl. No. 10/669,313, mailed on Jan. 11, 2006.
Notice of Allowance received for U.S. Appl. No. 10/669,313, mailed on Jun. 28, 2006.
Notice of Allowance received for U.S. Appl. No. 10/682,459, mailed on Apr. 1, 2011.
Notice of Allowance received for U.S. Appl. No. 10/786,444, mailed on Jul. 11, 2013.
Notice of Allowance received for U.S. Appl. No. 10/787,073, mailed on Aug. 25, 2010.
Notice of Allowance received for U.S. Appl. No. 10/787,073, mailed on Feb. 17, 2010.
Notice of Allowance received for U.S. Appl. No. 10/908,721, filed Jul. 18, 2013.
Notice of Allowance received for U.S. Appl. No. 11/048,503, filed Jan. 11, 2010.
Notice of Allowance received for U.S. Appl. No. 11/048,503, filed Jul. 30, 2010.
Notice of Allowance received for U.S. Appl. No. 11/048,503, mailed on Apr. 26, 2010.
Notice of Allowance received for U.S. Appl. No. 11/113,549, mailed on Mar. 14, 2014.
Notice of Allowance received for U.S. Appl. No. 11/152,562, mailed on Sep. 16, 2010.
Notice of Allowance received for U.S. Appl. No. 11/198,811, filed Jun. 29, 2010.
Notice of Allowance received for U.S. Appl. No. 11/344,891, filed Jan. 22, 2013.
Notice of Allowance received for U.S. Appl. No. 11/390,586, filed May 3, 2012.
Notice of Allowance received for U.S. Appl. No. 11/396,141, mailed on Nov. 4, 2013.
Notice of Allowance received for U.S. Appl. No. 11/396,731, filed Jul. 9, 2015.
Notice of Allowance received for U.S. Appl. No. 11/406,203, filed Jan. 29, 2008.
Notice of Allowance received for U.S. Appl. No. 11/406,203, filed Jun. 18, 2010.
Notice of Allowance received for U.S. Appl. No. 11/406,203, filed May 23, 2008.
Notice of Allowance received for U.S. Appl. No. 11/406,203, mailed on Sep. 22, 2008.
Notice of Allowance received for U.S. Appl. No. 11/411,925, mailed on Feb. 5, 2014.
Notice of Allowance received for U.S. Appl. No. 11/427,297, filed Jun. 26, 2012.
Notice of Allowance received for U.S. Appl. No. 11/427,309, filed Jun. 7, 2013.
Notice of Allowance received for U.S. Appl. No. 11/455,993, filed Aug. 11, 2014.
Notice of Allowance received for U.S. Appl. No. 11/532,325, filed Jan. 16, 2015.
Notice of Allowance received for U.S. Appl. No. 11/674,930, filed Apr. 3, 2014.
Notice of Allowance received for U.S. Appl. No. 11/675,462, filed Dec. 22, 2011.
Notice of Allowance received for U.S. Appl. No. 11/744,089, filed Aug. 8, 2013.
Notice of Allowance received for U.S. Appl. No. 11/767,818, filed Feb. 3, 2012.
Notice of Allowance received for U.S. Appl. No. 11/852, 190, filed on Feb. 12, 2014.
Notice of Allowance received for U.S. Appl. No. 11/958,295, filed Jun. 13, 2014.
Notice of Allowance received for U.S. Appl. No. 11/959,334, filed Apr. 14, 2010.
Notice of Allowance received for U.S. Appl. No. 11/959,334, filed Jan. 12, 2010.
Advisory Action received for U.S. Appl. No. 09/732,178, mailed on Jun. 10, 2003.
Advisory Action received for U.S. Appl. No. 12/106,928, filed Mar. 25, 2014.
Advisory Action received for U.S. Appl. No. 12/961,331, mailed on Sep. 20, 2013.
Advisory Action received for U.S. Appl. No. 15/056,281, filed Aug. 27, 2018.
Advisory Action received for U.S. Appl. No. 15/069,230, mailed on Oct. 22, 2018.
Amir Loshakove, et al., "Vascular Closure Device", PCT Publication No. WO 00/56223, Sep. 28, 2000.
Carpenter et al, Midterm results of the multicenter trial of the Powerlink bifurcated system for endovascular aortic aneurysm repair, Journal of Vascular Surgery, vol. 40, No. 5, Nov. 2004, p. 849-859.e5.
Database WPI; Section PQ, Week 200120; Derwent Publications Ltd., London GB; An 2001-203165; XP002199926 & ZA 200 100 528 A (Anthony T), Feb. 28, 2001 (Feb. 28, 2001) abstract.
Deepak Mital et al., Renal Transplantation Without Sutures Using The Vascular Clipping System For Renal Artery And Vein Anastomosis—A New Technique, Transplantation Issue, Oct. 1996, pp. 1171-1173, vol. 62—No. 8, Section of Transplantation Surgery, Department of General Surgery, Rush-Presbyterian/St. Luke's Medical Center, Chiqaqo, IL.
DL Wessel et al, Outpatient closure of the patent ductus arteriosus, Circulation, May 1988, pp. 1068-1071, vol. 77—No. 5, Department of Anesthesia, Children's Hospital, Boston, MA.
E Pikoulis et al, Arterial reconstruction with vascular clips is safe and quicker than sutured repair, Cardiovascular Surgery, Dec. 1998, pp. 573-578(6), vol. 6—No. 6, Department of Surgery, Uniformed Services University of the Health Sciences, Bethesda, MD.
Eisenack et al, Percutaneous Endovascular Aortic Aneurysm Repair: A Prospective Evaluation of Safety, Efficiency, and Risk Factors, Journal of Endovascular Ther., 2009, vol. 16, p. 708-713.
Examiner's Amendment received for U.S. Appl. No. 10/435,104, mailed on Jan. 3, 2006.
G Gershony et al, Novel vascular sealing device for closure of percutaneous vascular access sites, Cathet. Cardiovasc. Diagn., Jan. 1998, pp. 82-88, vol. 45.
Greenhalgh et al, Endovascular versus open repair of abdominal aortic aneurysm, The New England journal of medicine, vol. 362, No. 20, 2010, p. 1863-1871.
Grossman, W., Cardiac Catheterization and Angiography, 3rd Ed., Lea & Febiger, Philadelphia, pp. 1-49, 52-247. 1986.
H De Swart et al, A new hemostatic puncture closure device for the immediate sealing of arterial puncture sites, American journal of cardiology, Aug. 1993, pp. 445-449, vol. 72—No. 5, Department of Cardiology, Academic Hospital Maastricht, The Netherlands.
Hand tool for forming telephone connections—comprises pliers with reciprocably driven ram crimping clip around conductors against anvil, Derwent-ACC-No. 1978-B8090A. (Jan. 10, 1978).

(56) **References Cited**

OTHER PUBLICATIONS

Harrith M. Hasson M.D., Laparoscopic Cannula Cone with Means for Cannula Stabilization and Wound Closure, The Journal of the American Association of Gynecologic Laparoscopists, May 1998, pp. 183-185, vol. 5—No. 2, Division of Obstetrics and Gynecology, University of Chicago, Chigago, IL.

Howell et al, Percutaneous Repair of Abdominal Aortic Aneurysms Using the aneuRx Stent Graft and the Percutaneous Vascular Surgery Device, Catheterization and cardiovascular interventions, vol. 55, No. 3, 2002, p. 281-287.

https://www.thefreedictionary.com/flex, retrieved Sep. 2, 2018, definition of the term flex.

https://www.thefreedictionary.com/integral, retrieved Aug. 20, 2018, definition of the term integral.

Inlet Medical Inc. Brochure, pp. 1-2, referencing Om Elashry et al., Comparative clinical study of port-closure techniques following laparoscopic surgery, Depatiment of Surgery, Mallickrodt Institute of Radiography, J Am Coll Surg., Oct. 1996, pp. 335-344, vol. 183—No. 4.

Interview Summary received for U.S. Appl. No. 12/724,304, filed Mar. 13, 2012.

Interview Summary received for U.S. Appl. No. 14/928,950, mailed on Jun. 4, 2018.

Interview Summary received for U.S. Appl. No. 15/069,230, filed May 1, 2019.

Interview Summary received for U.S. Appl. No. 15/419,335, filed Oct. 1, 2018.

J. Findlay et al, Carotid Arteriotomy Closure Using a Vascular Clip System, Neurosurgery, Mar. 1998, pp. 550-554, vol. 42—No. 3, Division of Neurosurgery, University of Alberta, Edmonton, Canada.

Jean-Baptiste et al., Percutaneous closure devices for endovascular repair of infrarenal abdominal aortic aneurysms: a prospective, non-randomized comparative study, European Journal of Vascular and Endovascular Surgery, vol. 35, No. 4, 2008, p. 422-428.

Jeremy L Gilbert PhD, Wound Closure Biomaterials And Devices, Shock., Mar. 1999, p. 226, vol. 11—No. 3, Institution Northwestern University (editorial review).

Jochen T. Cremer, MD, et al., Different approaches for minimally invasive closure of atrial septal defects, Ann. Thorac. Surg., Nov. 1998, pp. 1648-1652, vol. 67, a Division of Thoracic and Cardiovascular Surgery, Surgical Center, Hannover Medical School. Hannover, Germany.

K Narayanan et al, Simultaneous primary closure of four fasciotomy wounds in a single setting using the Sure-Closure device, Injury, Jul. 1996, pp. 449-451, vol. 27—No. 6, Department of Surgery, Mercy Hospital of Pittsburgh, PA.

Krajcer and Gregoric, Totally percutaneous aortic aneurysm repair: methods and outcomes using the fully integrated IntuiTrak endovascular system, The Journal of cardiovascular surgery, vol. 51, No. 4, 2010, p. 493-501.

Lederle et al, Outcomes foilowing endovascular vs open repair of abdominal aortic aneurysm: a randomized trial, Jama, vol. 302, No. 14, 2009, p. 1535-1542.

Lee et al, Total percutaneous access for endovascular aortic aneurysm repair ("Preclose" technique), Journal of vascular surgery, vol. 45, No. 6, 2007, p. 1095-1101.

Malkawi et al, Percutaneous access for endovascular aneurysm repair: a systematic review, European Journal of Vascular and Endovascular Surgery, vol. 39, No. 6, 2010, p. 676-682.

Marshall, AC. & Lock, J.E.; "Structural and compliant anatomy of the patent foramen ovale in patients undergoing transcatheter closure", Am. Heart Journ., 140(2):303-307, Aug. 2000.

McCarthy, et al., "Tension (Stay) Suture Bridge", J. of International College of Surgeons, 34(5), pp. 613-614 (Nov. 1960).

MD Gonze et al., Complications associated with percutaneous closure devices, Conference: Annual Meeting of the Society for Clinical Vascular Surgery, The American journal of surgery, Mar. 1999, pp. 209-211, vol. 178, No. 3, Department of Surgery, Section of Vascular Surgery, Ochsner Medical Institutions, New Orleans, LA.

MD Hellinger et al, Effective peritoneal and fascial closure of abdominal trocar sites utilizing the Endo-Judge, J Laparoendosc Surg., Oct. 1996, pp. 329-332, vol. 6—No. 5, Orlando Regional Medical Center, FL.

Michael Gianturco, A Play on Catheterization, Forbes, Dec. 1996, p. 146, vol. 158—No. 15.

Morasch et al, Percutaneous repair of abdominal aortic aneurysm, Journal of vascular surgery, vol. 40, No. 1, 2004, p. 12-16.

Nakamura, S. et al., Techniques for Palmaz-Schatz Stent Deployment in Lesions With a Large Side Branch, Catherterization and Cardiovascular Diagnosis, 34: 353-361, 1995.

Notice of Allowance received for U.S. Appl. No. 09/478,179, mailed on Nov. 6, 2000.

Notice of Allowance received for U.S. Appl. No. 09/546,998, mailed on May 6, 2002.

Notice of Allowance received for U.S. Appl. No. 09/610,238, mailed on Feb. 11, 2002.

Notice of Allowance received for U.S. Appl. No. 09/610,238, mailed on Mar. 26, 2001.

Notice of Allowance received for U.S. Appl. No. 09/680,837, mailed on Jun. 16, 2003.

Notice of Allowance received for U.S. Appl. No. 09/732,178, mailed on Nov. 17, 2003.

Notice of Allowance received for U.S. Appl. No. 09/732,835, mailed on Mar. 17, 2004.

Office Action received for U.S. Appl. No. 10/667,144, mailed on Nov. 23, 2009.

Office Action received for U.S. Appl. No. 10/667,144, mailed on Sep. 19, 2006.

Office Action received for U.S. Appl. No. 10/669,313, mailed on Oct. 31, 2005.

Office Action received for U.S. Appl. No. 10/682,459, mailed on Apr. 2, 2008.

Office Action received for U.S. Appl. No. 10/682,459, mailed on Apr. 28, 2010.

Office Action received for U.S. Appl. No. 10/682,459, mailed on Dec. 4, 2008.

Office Action received for U.S. Appl. No. 10/682,459, mailed on Dec. 23, 2009.

Office Action received for U.S. Appl. No. 10/682,459, mailed on Jun. 10, 2009.

Office Action received for U.S. Appl. No. 10/786,444, mailed on Apr. 17, 2007.

Office Action received for U.S. Appl. No. 10/786,444, mailed on Aug. 31, 2007.

Office Action received for U.S. Appl. No. 10/786,444, mailed on Jan. 14, 2010.

Office Action received for U.S. Appl. No. 10/786,444, mailed on Jun. 18, 2009.

Office Action received for U.S. Appl. No. 10/786,444, mailed on Oct. 17, 2008.

Office Action received for U.S. Appl. No. 10/786,444, mailed on Oct. 30, 2006.

Office Action received for U.S. Appl. No. 10/787,073, mailed on Aug. 13, 2009.

Office Action received for U.S. Appl. No. 10/787,073, mailed on Feb. 22, 2008.

Office Action received for U.S. Appl. No. 10/787,073, mailed on Nov. 12, 2008.

Office Action received for U.S. Appl. No. 10/787,073, mailed on Nov. 30, 2006.

Office Action received for U.S. Appl. No. 10/787,073, mailed on Sep. 5, 2007.

Office Action received for U.S. Appl. No. 10/908,721, filed Jan. 25, 2008.

Office Action received for U.S. Appl. No. 10/908,721, mailed on Aug. 10, 2007.

Office Action received for U.S. Appl. No. 10/908,721, mailed on Feb. 2, 2010.

Office Action received for U.S. Appl. No. 10/908,721, mailed on Jun. 23, 2009.

Office Action received for U.S. Appl. No. 10/908,721, mailed on Nov. 25, 2008.

(56) **References Cited**

OTHER PUBLICATIONS

Office Action received for U.S. Appl. No. 10/908,721, mailed on Oct. 19, 2006.
Office Action received for U.S. Appl. No. 11/048,503, mailed on Jun. 26, 2009.
Office Action received for U.S. Appl. No. 11/048,503, mailed on Mar. 13, 2009.
Office Action received for U.S. Appl. No. 11/113,549, mailed on Apr. 16, 2008.
Office Action received for U.S. Appl. No. 11/113,549, mailed on Feb. 6, 2007.
Office Action received for U.S. Appl. No. 11/113,549, mailed on Jan. 4, 2011.
Office Action received for U.S. Appl. No. 11/113,549, mailed on Jul. 6, 2010.
Office Action received for U.S. Appl. No. 11/113,549, mailed on Jul. 21, 2009.
Office Action received for U.S. Appl. No. 11/113,549, mailed on May 30, 2007.
Office Action received for U.S. Appl. No. 11/113,549, mailed on Nov. 9, 2007.
Office Action received for U.S. Appl. No. 11/152,562, mailed on Feb. 13, 2009.
Office Action received for U.S. Appl. No. 11/152,562, mailed on Jul. 6, 2009.
Office Action received for U.S. Appl. No. 11/152,562, mailed on Mar. 31, 2010.
Office Action received for U.S. Appl. No. 11/152,562, mailed on May 13, 2008.
Office Action received for U.S. Appl. No. 11/198,811, filed Apr. 6, 2009.
Office Action received for U.S. Appl. No. 11/198,811, mailed on Aug. 26, 2008.
Office Action received for U.S. Appl. No. 11/198,811, mailed on Sep. 22, 2009.
Office Action received for U.S. Appl. No. 11/344,793, filed Jan. 22, 2009.
Office Action received for U.S. Appl. No. 11/344,868, filed Mar. 25, 2009.
Office Action received for U.S. Appl. No. 11/344,891, filed Apr. 29, 2008.
Office Action received for U.S. Appl. No. 11/344,891, filed Dec. 8, 2008.
Office Action received for U.S. Appl. No. 11/344,891, mailed on Feb. 26, 2009.
Office Action received for U.S. Appl. No. 11/344,891, mailed on May 7, 2010.
Office Action received for U.S. Appl. No. 11/344,891, mailed on Oct. 7, 2009.
Office Action received for U.S. Appl. No. 11/390,586, mailed on Jul. 6, 2010.
Office Action received for U.S. Appl. No. 11/390,586, mailed on Jun. 24, 2009.
Office Action received for U.S. Appl. No. 10/240,183, mailed on Dec. 17, 2004.
Office Action received for U.S. Appl. No. 10/240,183, mailed on Jul. 27, 2004.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Aug. 13, 2009.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Feb. 9, 2005.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Feb. 26, 2009.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Jan. 27, 2010.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Jun. 15, 2010.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Jun. 27, 2008.
Office Action received for U.S. Appl. No. 10/264,306, mailed on Oct. 4, 2005.
Office Action received for U.S. Appl. No. 10/335,075, mailed on Apr. 21, 2006.
Office Action received for U.S. Appl. No. 10/335,075, mailed on Aug. 10, 2005.
Office Action received for U.S. Appl. No. 10/335,075, mailed on Dec. 19, 2005.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Apr. 29, 2009.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Aug. 23, 2006.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Feb. 13, 2007.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Mar. 6, 2008.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Nov. 4, 2008.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Nov. 30, 2005.
Office Action received for U.S. Appl. No. 10/356,214, mailed on Sep. 12, 2007.
Office Action received for U.S. Appl. No. 10/435,104, mailed on Jun. 2, 2010.
Office Action received for U.S. Appl. No. 10/435,104, mailed on Jun. 10, 2004.
Office Action received for U.S. Appl. No. 10/435,104, mailed on May 16, 2006.
Office Action received for U.S. Appl. No. 10/455,768, mailed on Nov. 16, 2004.
Office Action received for U.S. Appl. No. 10/486,067, mailed on Jan. 10, 2006.
Office Action received for U.S. Appl. No. 10/486,070, mailed on Apr. 20, 2005.
Office Action received for U.S. Appl. No. 10/486,070, mailed on Aug. 10, 2005.
Office Action received for U.S. Appl. No. 10/517,004, mailed on Aug. 13, 2007.
Office Action received for U.S. Appl. No. 10/517,004, mailed on Jan. 30, 2008.
Office Action received for U.S. Appl. No. 10/519,778, mailed on Feb. 23, 2006.
Office Action received for U.S. Appl. No. 10/541,083, mailed on May 5, 2008.
Office Action received for U.S. Appl. No. 10/541,083, mailed on Oct. 16, 2007.
Office Action received for U.S. Appl. No. 10/541,083, mailed on Oct. 31, 2007.
Office Action received for U.S. Appl. No. 10/616,832, mailed on Jan. 22, 2008.
Office Action received for U.S. Appl. No. 10/616,832, mailed on Jul. 21, 2009.
Office Action received for U.S. Appl. No. 10/616,832, mailed on Jun. 30, 2006.
Office Action received for U.S. Appl. No. 10/616,832, mailed on May 29, 2007.
Office Action received for U.S. Appl. No. 10/616,832, mailed on Oct. 20, 2006.
Office Action received for U.S. Appl. No. 10/616,832, mailed on Sep. 17, 2008.
Office Action received for U.S. Appl. No. 10/617,090, mailed on Mar. 22, 2005.
Office Action received for U.S. Appl. No. 10/638,115, mailed on Feb. 7, 2008.
Office Action received for U.S. Appl. No. 10/638,115, mailed on Jan. 31, 2007.
Office Action received for U.S. Appl. No. 10/638,115, mailed on Oct. 29, 2008.
Office Action received for U.S. Appl. No. 10/638,115, mailed on Sep. 18, 2007.
Office Action received for U.S. Appl. No. 10/667,144, mailed on Dec. 5, 2007.

(56) **References Cited**

OTHER PUBLICATIONS

Office Action received for U.S. Appl. No. 10/667,144, mailed on Jun. 6, 2011.
Office Action received for U.S. Appl. No. 10/667,144, mailed on Jun. 22, 2010.
Office Action received for U.S. Appl. No. 10/667,144, mailed on Mar. 24, 2009.
Office Action received for U.S. Appl. No. 10/667,144, mailed on May 2, 2007.
Office Action received for U.S. Appl. No. 10/667,144, mailed on May 12, 2008.
Office Action received for U.S. Appl. No. 10/667,144, mailed on Nov. 19, 2007.
Office Action received for U.S. Appl. No. 14/077,007, filed Jan. 29, 2016.
Office Action received for U.S. Appl. No. 14/077,007, filed Jul. 27, 2015.
Office Action received for U.S. Appl. No. 14/246,926, filed Aug. 5, 2015.
Office Action received for U.S. Appl. No. 14/246,926, filed Jun. 15, 2016.
Office Action received for U.S. Appl. No. 14/246,926, filed Nov. 23, 2015.
Office Action received for U.S. Appl. No. 14/246,973, filed Aug. 3, 2015.
Office Action received for U.S. Appl. No. 14/246,973, filed Jul. 7, 2016.
Office Action received for U.S. Appl. No. 14/246,973, filed Nov. 24, 2015.
Office Action received for U.S. Appl. No. 14/312,339, filed Aug. 28, 2017.
Office Action received for U.S. Appl. No. 14/312,339, filed Dec. 28, 2017.
Office Action received for U.S. Appl. No. 14/312,339, filed Jan. 22, 2016.
Office Action received for U.S. Appl. No. 14/312,339, filed Jan. 31, 2017.
Office Action received for U.S. Appl. No. 14/312,339, filed May 3, 2016.
Office Action received for U.S. Appl. No. 14/312,339, filed May 23, 2017.
Office Action received for U.S. Appl. No. 14/323,753, mailed on Nov. 3, 2015.
Office Action received for U.S. Appl. No. 14/466,576, mailed on Jul. 8, 2015.
Office Action received for U.S. Appl. No. 14/539,830, filed Jan. 29, 2016.
Office Action received for U.S. Appl. No. 14/539,830, filed Jul. 26, 2016.
Office Action received for U.S. Appl. No. 14/732,977, filed Sep. 26, 2017.
Office Action received for U.S. Appl. No. 14/839,658, filed May 30, 2017.
Office Action received for U.S. Appl. No. 14/839,658, filed Sep. 19, 2017.
Office Action received for U.S. Appl. No. 14/855,080, filed Apr. 2, 2018.
Office Action received for U.S. Appl. No. 14/855,080, filed Apr. 15, 2019.
Office Action received for U.S. Appl. No. 14/855,080, filed Sep. 21, 2018.
Office Action received for U.S. Appl. No. 14/928,950, filed Mar. 30, 2018.
Office Action received for U.S. Appl. No. 14/928,950, filed Sep. 26, 2017.
Office Action received for U.S. Appl. No. 15/056,281, filed Feb. 5, 2018.
Office Action received for U.S. Appl. No. 15/056,281, filed Jan. 14, 2019.
Office Action received for U.S. Appl. No. 15/056,281, filed Jun. 13, 2018.
Office Action received for U.S. Appl. No. 15/056,281, filed Sep. 19, 2018.
Office Action received for U.S. Appl. No. 15/069,230, filed Aug. 7, 2018.
Office Action received for U.S. Appl. No. 15/069,230, filed Feb. 15, 2018.
Office Action received for U.S. Appl. No. 15/069,230, filed Mar. 19, 2019.
Office Action received for U..S. Appl. No. 15/142,106, filed on Feb. 13, 2019.
Office Action received for U.S. Appl. No. 15/142,106, filed Sep. 7, 2018.
Office Action received for U.S. Appl. No. 15/142,106, mailed on Jun. 13, 2019.
Office Action received for U.S. Appl. No. 15/149,784, mailed on May 11, 2017.
Office Action received for U.S. Appl. No. 15/222,397, mailed on Jan. 23, 2017.
Office Action received for U.S. Appl. No. 15/344,978, filed Dec. 10, 2018.
Office Action received for U.S. Appl. No. 15/356,028, filed Aug. 29, 2018.
Office Action received for U.S. Appl. No. 15/356,028, filed Feb. 22, 2018.
Office Action received for U.S. Appl. No. 15/419,335, filed Aug. 13, 2018.
Office Action received for U.S. Appl. No. 15/946,071, mailed on Mar. 25, 2020.
Office Action received for U.S. Appl. No. 15/976,425, mailed on Jun. 22, 2020.
Office Action received for U.S. Appl. No. 15/976,425, mailed on Mar. 6, 2020.
Office Action received for U.S. Appl. No. 29/296,370, mailed on Aug. 18, 2008.
Office Action received for U.S. Pat. No. 6,632,238, mailed on Feb. 26, 2003.
Office Action received for U.S. Appl. No. 10/682,459, mailed on Oct. 12, 2010.
Notice of Allowance received for U.S. Appl. No. 11/959,334, filed Jul. 23, 2010.
Notice of Allowance received for U.S. Appl. No. 12/106,928, mailed on Oct. 3, 2014.
Notice of Allowance received for U.S. Appl. No. 12/106,937, filed Mar. 5, 2015.
Notice of Allowance received for U.S. Appl. No. 12/113,851, filed Feb. 20, 2015.
Notice of Allowance received for U.S. Appl. No. 12/114,091, mailed on Apr. 6, 2016.
Notice of Allowance received for U.S. Appl. No. 12/122,603, filed Sep. 23, 2015.
Notice of Allowance received for U.S. Appl. No. 12/143,020, mailed on Feb. 23, 2012.
Notice of Allowance received for U.S. Appl. No. 12/393,877, filed Aug. 4, 2014.
Notice of Allowance received for U.S. Appl. No. 12/402,398, filed Mar. 13, 2013.
Notice of Allowance received for U.S. Appl. No. 12/403,256, mailed on Aug. 19, 2010.
Notice of Allowance received for U.S. Appl. No. 12/481,377, mailed on Aug. 10, 2012.
Notice of Allowance received for U.S. Appl. No. 12/608,769, filed Nov. 5, 2012.
Notice of Allowance received for U.S. Appl. No. 12/608,773, filed Sep. 17, 2015.
Notice of Allowance received for U.S. Appl. No. 12/642,319, filed May 27, 2014.
Notice of Allowance received for U.S. Appl. No. 12/684,400, filed Jul. 28, 2015.
Notice of Allowance received for U.S. Appl. No. 12/684,470, filed Apr. 22, 2016.

(56) **References Cited**

OTHER PUBLICATIONS

Notice of Allowance received for U.S. Appl. No. 12/684,562, filed Feb. 17, 2015.
Notice of Allowance received for U.S. Appl. No. 12/724,304, filed Jul. 11, 2012.
Notice of Allowance received for U.S. Appl. No. 12/848,642, filed Feb. 3, 2014.
Notice of Allowance received for U.S. Appl. No. 12/850,242, filed Aug. 6, 2013.
Notice of Allowance received for U.S. Appl. No. 12/897,358, filed Jan. 12, 2012.
Notice of Allowance received for U.S. Appl. No. 12/897,358, filed Mar. 5, 2012.
Notice of Allowance received for U.S. Appl. No. 12/941,809, mailed on Feb. 3, 2014.
Notice of Allowance received for U.S. Appl. No. 12/945,646, filed Feb. 21, 2012.
Notice of Allowance received for U.S. Appl. No. 12/950,628, filed Apr. 25, 2014.
Notice of Allowance received for U.S. Appl. No. 12/955,859, filed Aug. 1, 2013.
Notice of Allowance received for U.S. Appl. No. 12/961,331, filed Apr. 25, 2014.
Notice of Allowance received for U.S. Appl. No. 12/966,923, mailed on Feb. 3, 2012.
Notice of Allowance received for U.S. Appl. No. 12/973,204, filed Mar. 7, 2012.
Notice of Allowance received for U.S. Appl. No. 12/987,792, filed Aug. 25, 2014.
Notice of Allowance received for U.S. Appl. No. 13/028,041, filed Aug. 21, 2013.
Notice of Allowance received for U.S. Appl. No. 13/030,922, filed Jan. 8, 2014.
Notice of Allowance received for U.S. Appl. No. 13/039,087, mailed on Nov. 6, 2012.
Notice of Allowance received for U.S. Appl. No. 13/111,371, filed Jun. 6, 2013.
Notice of Allowance received for U.S. Appl. No. 13/112,618, filed Jul. 6, 2016.
Notice of Allowance received for U.S. Appl. No. 13/153,594, filed Oct. 16, 2013.
Notice of Allowance received for U.S. Appl. No. 13/222,899, filed Jan. 7, 2016.
Notice of Allowance received for U.S. Appl. No. 13/308,227, filed Feb. 1, 2016.
Notice of Allowance received for U.S. Appl. No. 13/488,233, filed Feb. 5, 2013.
Notice of Allowance received for U.S. Appl. No. 13/490,143, filed Apr. 29, 2013.
Notice of Allowance received for U.S. Appl. No. 13/525,839, filed Jul. 15, 2013.
Notice of Allowance received for U.S. Appl. No. 13/725,589, mailed on Mar. 18, 2016.
Notice of Allowance received for U.S. Appl. No. 13/791,829, mailed on Oct. 8, 2013.
Notice of Allowance received for U.S. Appl. No. 13/791,846, filed Oct. 27, 2015.
Notice of Allowance received for U.S. Appl. No. 13/898,202, mailed on Feb. 10, 2015.
Notice of Allowance received for U.S. Appl. No. 13/908,796, filed Nov. 6, 2015.
Notice of Allowance received for U.S. Appl. No. 14/017,039, filed Apr. 4, 2016.
Notice of Allowance received for U.S. Appl. No. 14/023,428, filed Jan. 4, 2018.
Notice of Allowance received for U.S. Appl. No. 14/077,007, filed Aug. 12, 2016.
Notice of Allowance received for U.S. Appl. No. 14/246,926, filed Oct. 3, 2016.

* cited by examiner

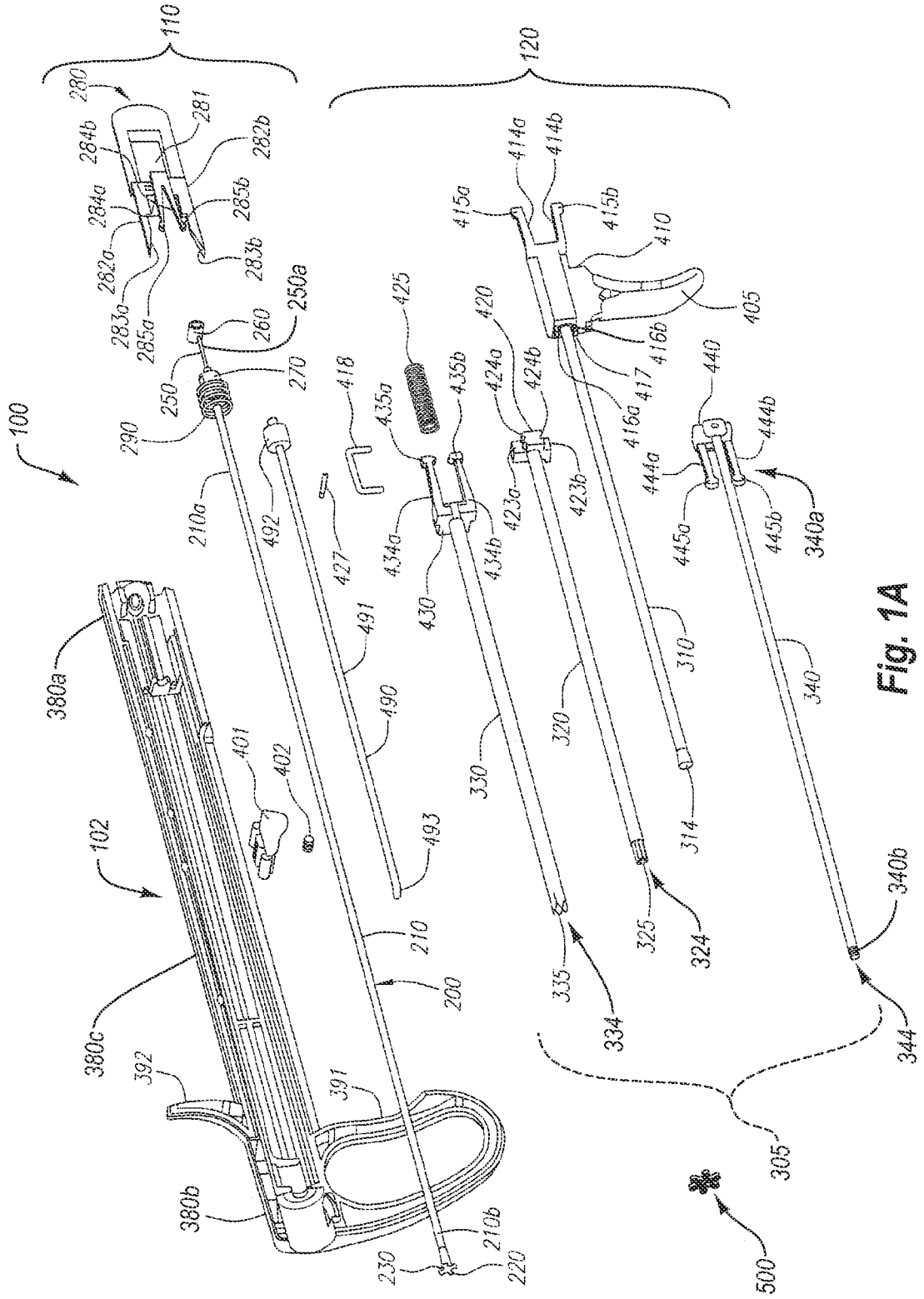

100
102
110
120
200
210
210a
210b
220
230
250
250a
260
270
280
281
282a
282b
283a
283b
284a
284b
285a
285b
290
305
310
314
320
324
325
330
334
335
340
340a
340b
344
380a
380b
380c
391
392
401
402
410
415a
415b
416a
416b
417
418
420
423a
423b
424a
424b
425
427
430
434a
434b
435a
435b
440
444a
444b
445a
445b
490
491
492
493
500

Fig. 1A

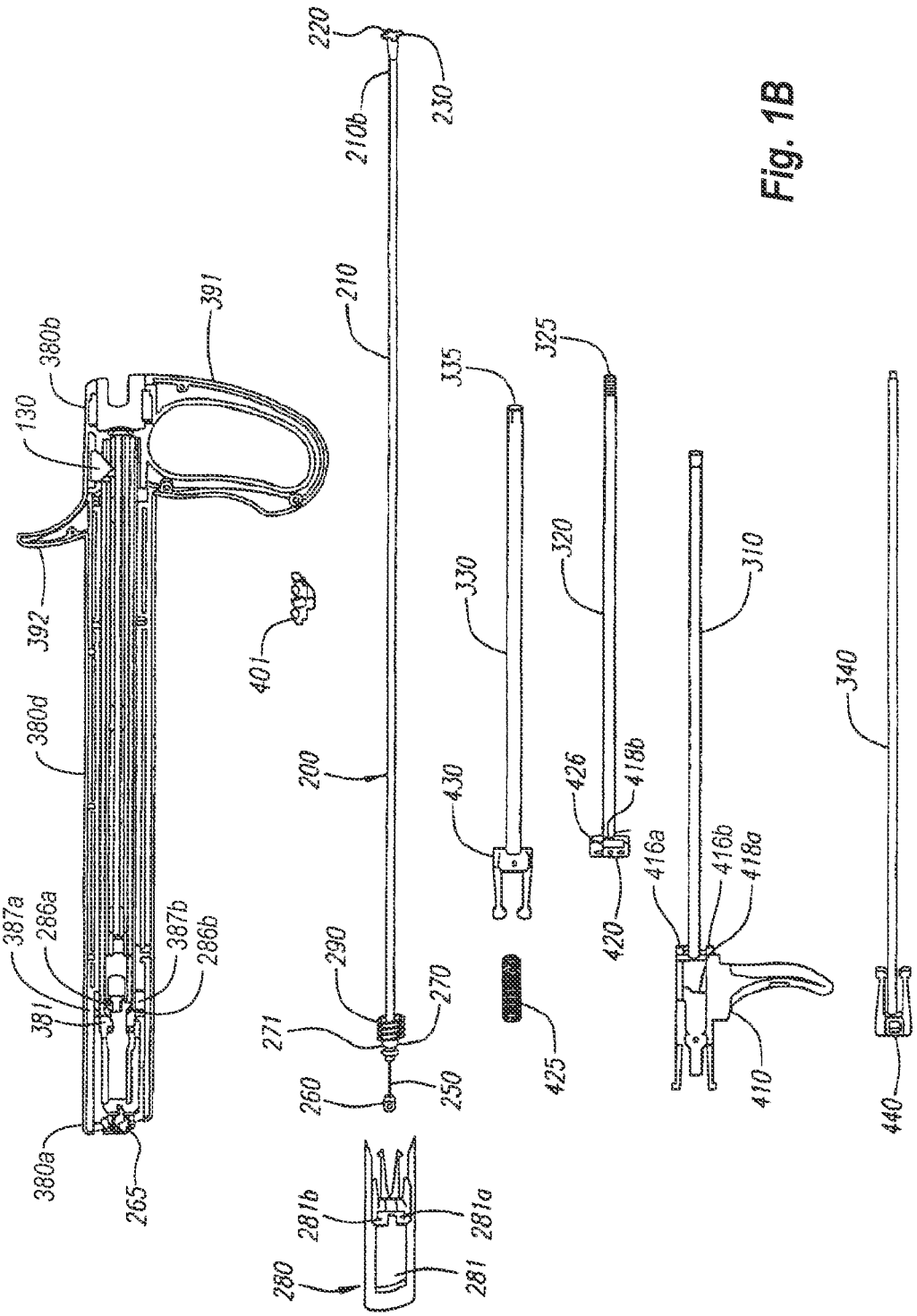

220
230
210b
210
391
380b
130
392
401
335
325
330
320
310
340
380d
200
430
426
416b
387a
286a
387b
286b
381
290
270
271
260
250
425
420
416a
416b
418a
410
440
380a
265
281b
281a
280
281

Fig. 1B

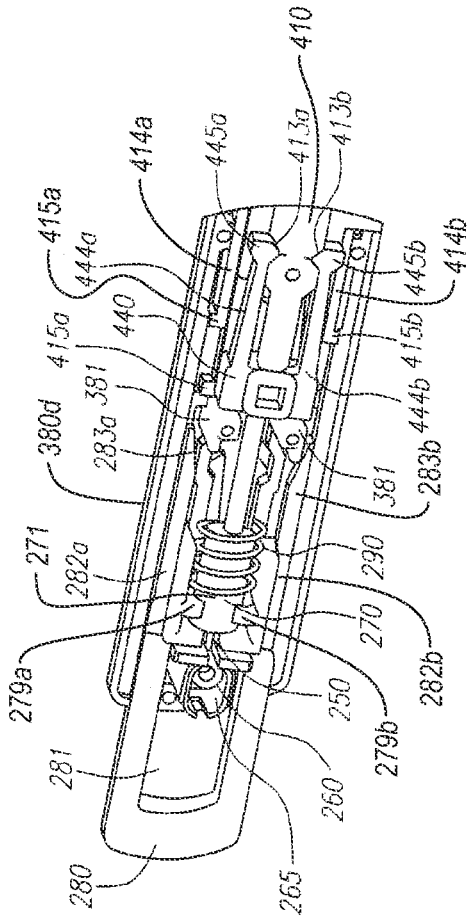

410
414a
445a
413a
413b
415a
444a
414b
445b
440
415a
415b
381
380d
283a
444b
283b
381
271
282a
290
270
282b
279a
250
279b
281
260
280
265

Fig. 3A

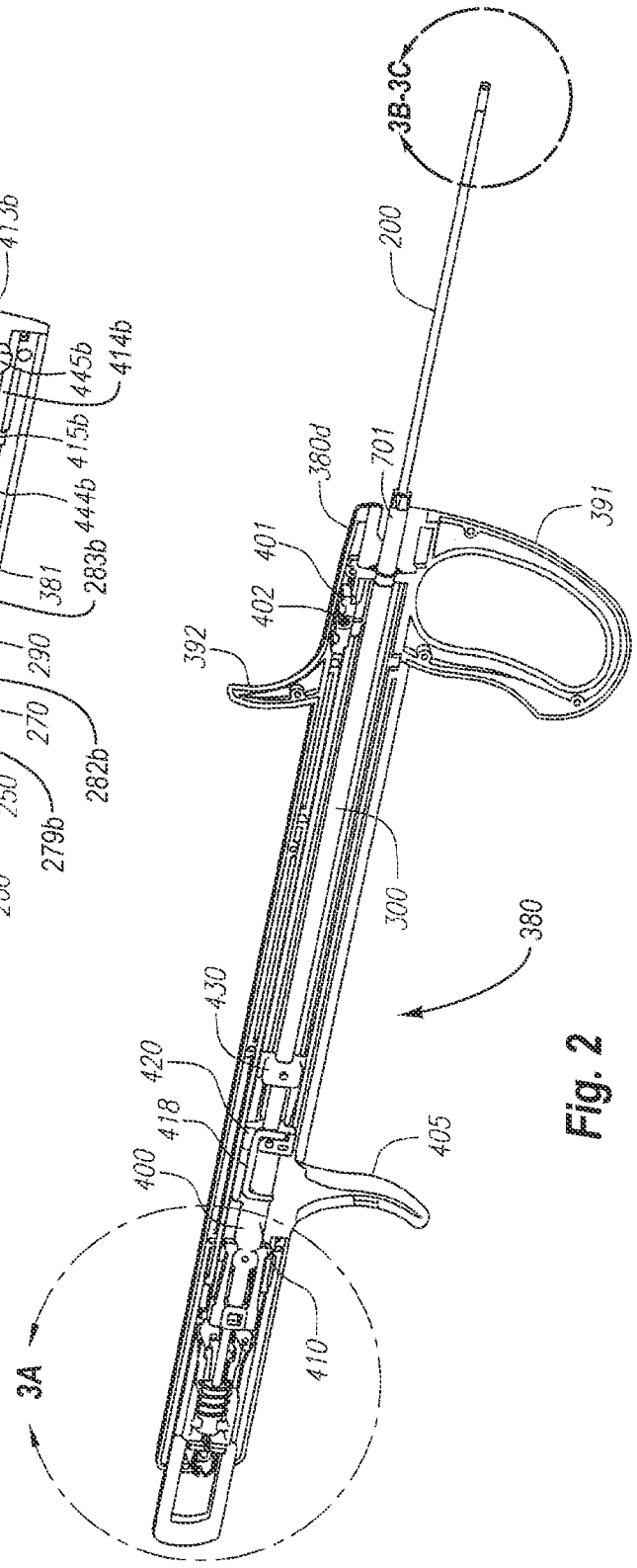

3B-3C
200
380d
701
391
401
402
392
300
380
430
420
418
400
405
3A
410

Fig. 2

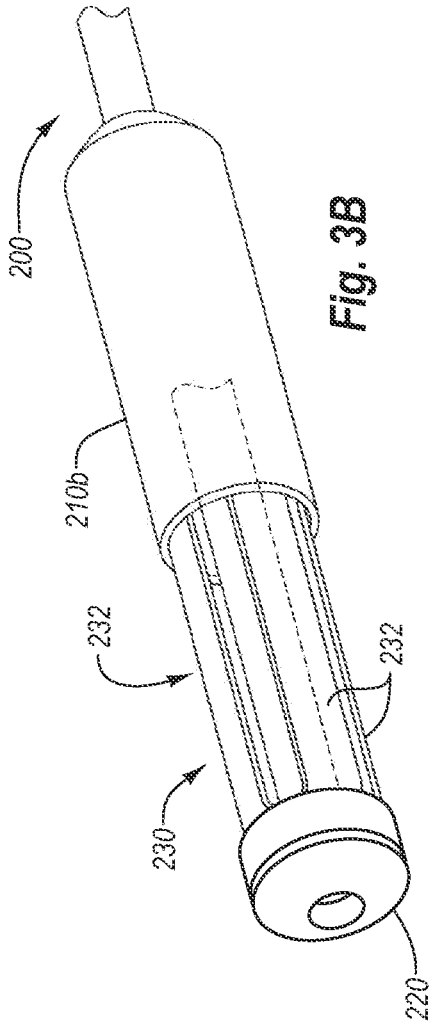


Fig. 3B

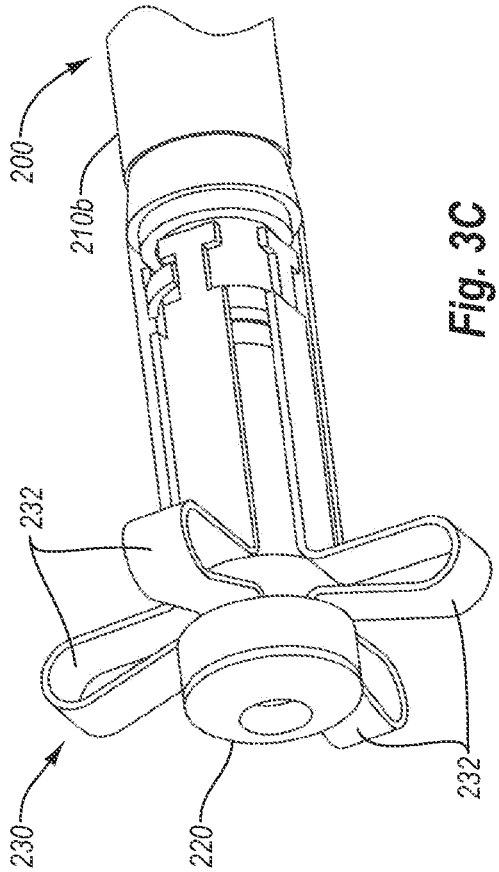


Fig. 3C

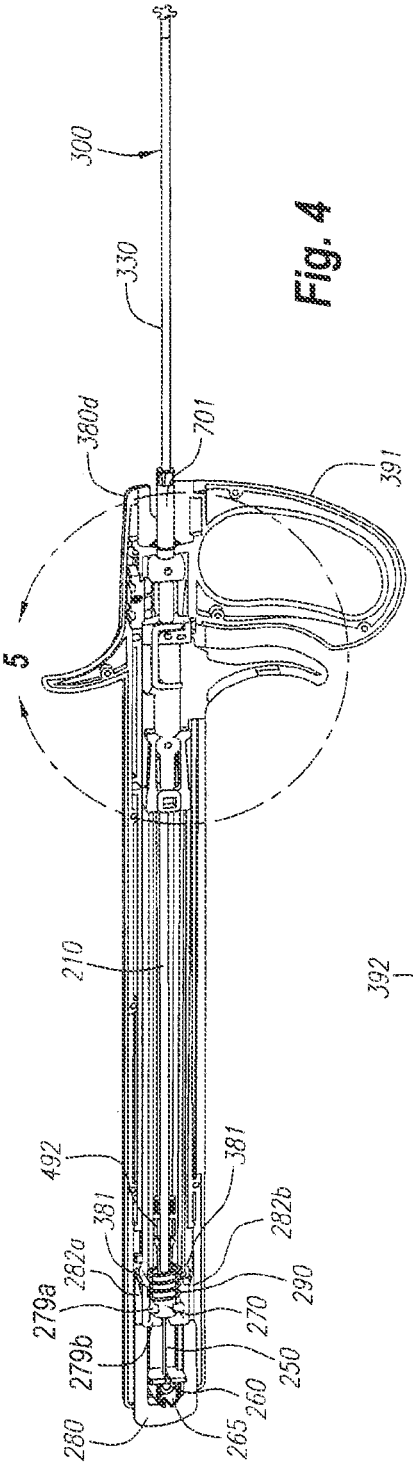

300
330
380d
701
391
5
210
492
381
381
282b
282a
279a
290
279b
270
250
260
260
280
265

Fig. 4

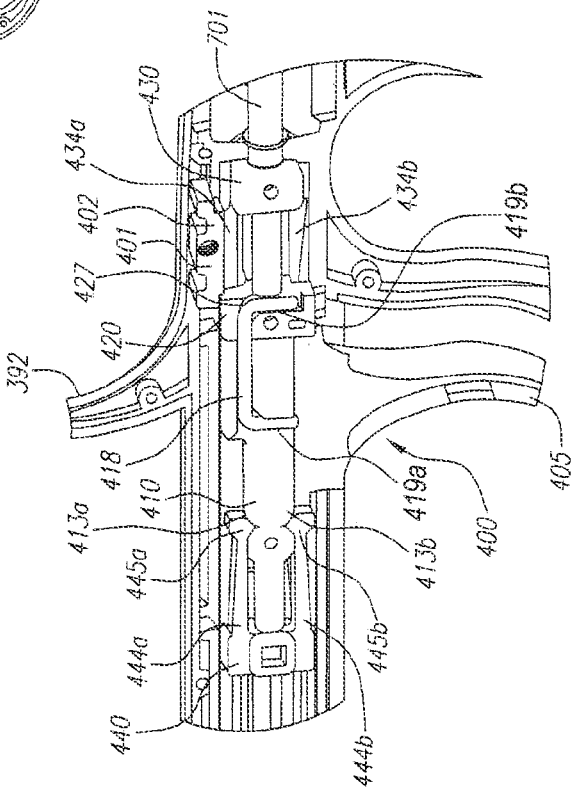

701
430
434a
434b
402
419b
401
427
420
392
418
410
413a
419a
445a
413b
400
444a
445b
440
444b
405

Fig. 5

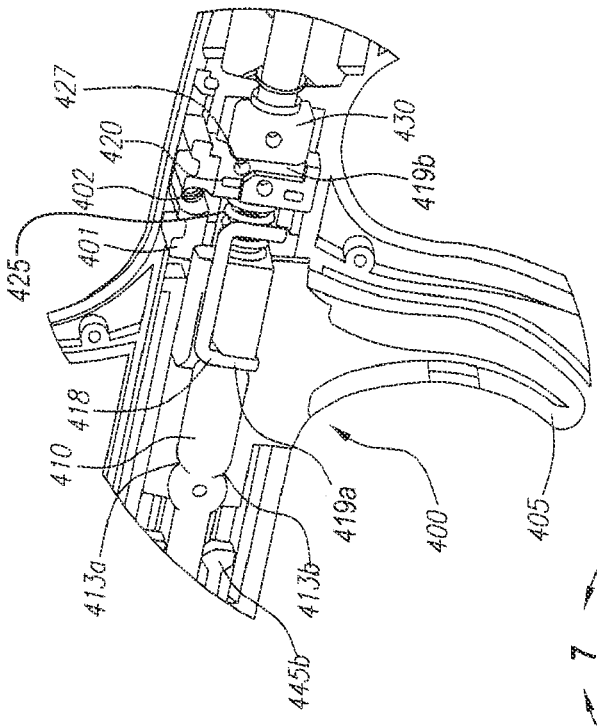

427
420
402
401
425
430
419b
418
410
413a
419a
400
405
413b
445b

Fig. 7

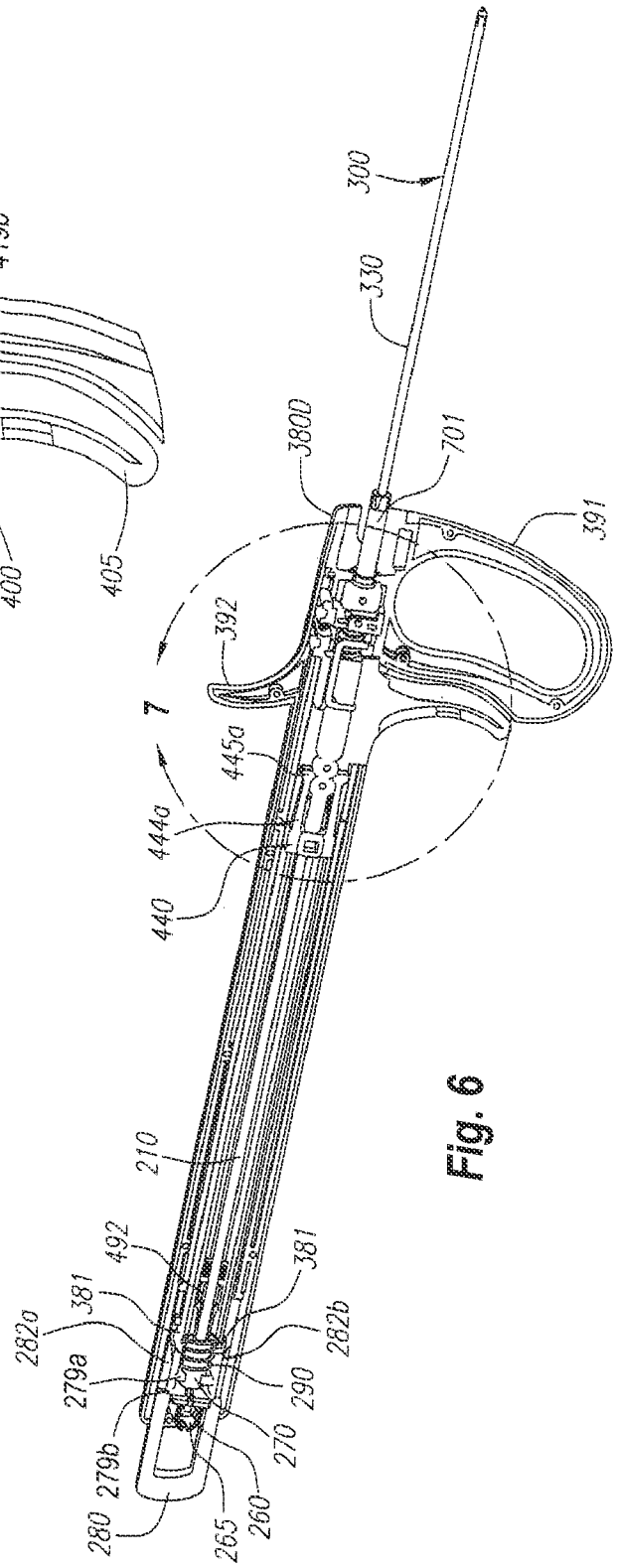

300
330
380D
701
391
392
7
445a
444a
440
210
492
381
282a
279a
279b
280
265
260
270
290
282b

Fig. 6

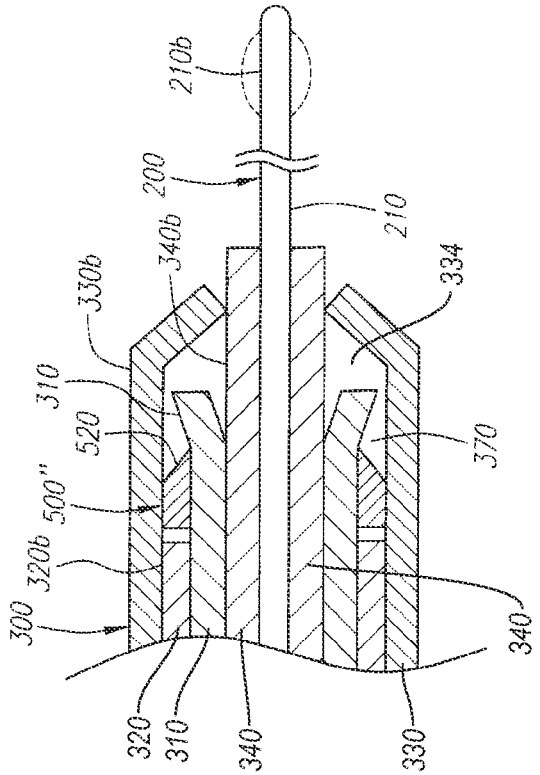

100
210b
200
210
340b
330b
334
310
520
370
500''
320b
300
340
320
310
340
330

Fig. 8

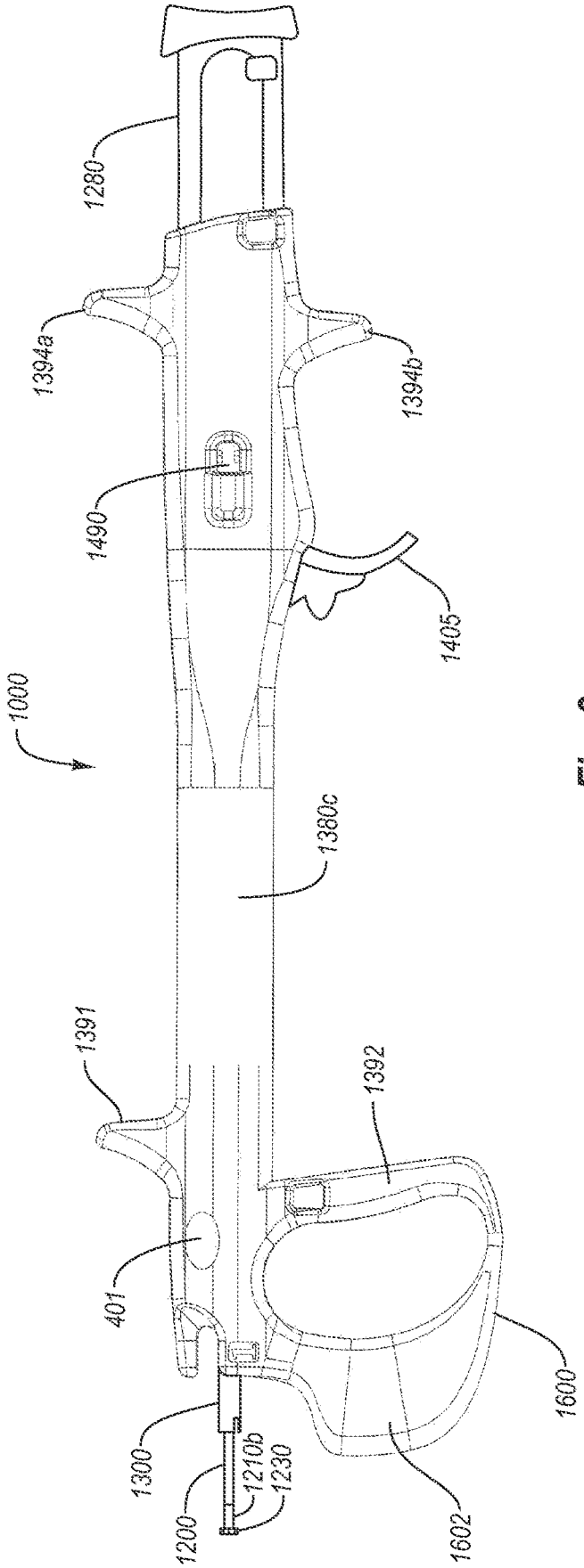

1280
1394a
1394b
1490
1405
1000
1380c
1391
1392
401
1600
1300
1210b
1230
1200
1602

Fig. 9

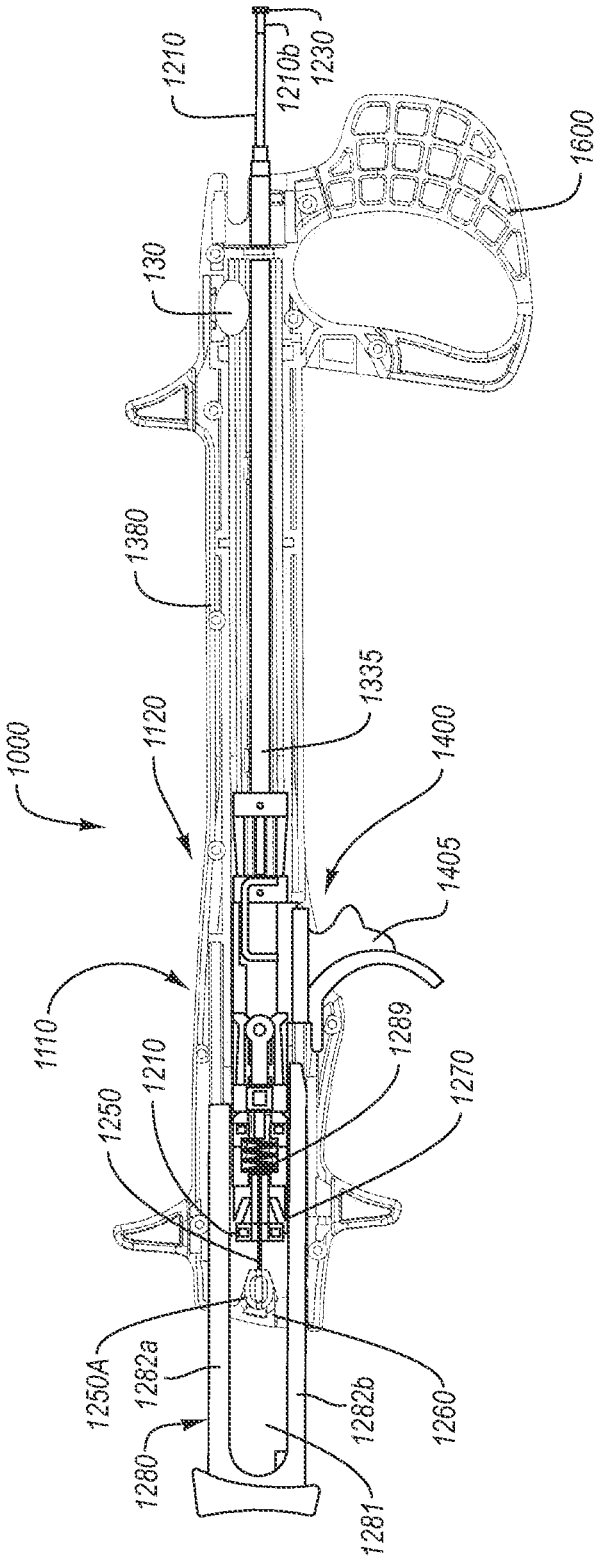

1210
1210b
1230
1600
130
1380
1335
1000
1120
1400
1405
1110
1289
1210
1270
1250
1250A
1282a
1282b
1260
1280
1281

Fig. 10

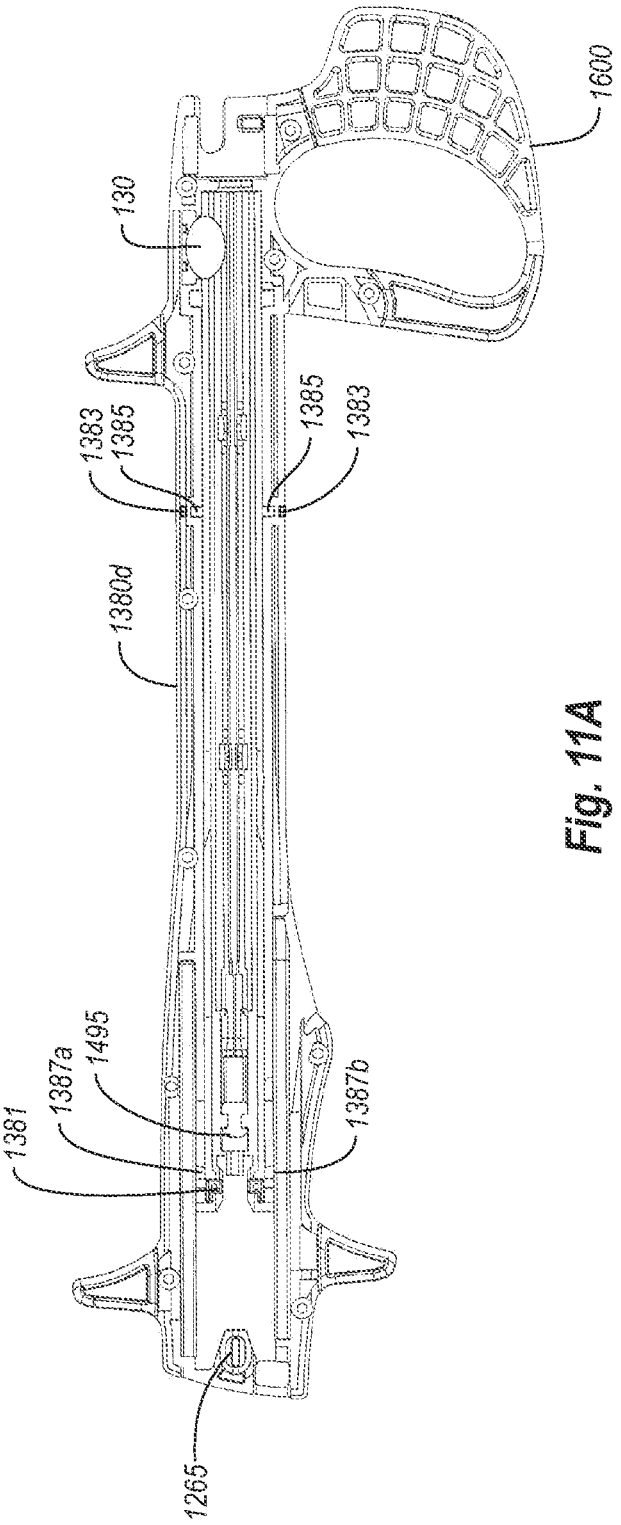

1600
130
1383
1385
1385
1383
1380d
1381
1387a
1495
1387b
1265

Fig. 11A

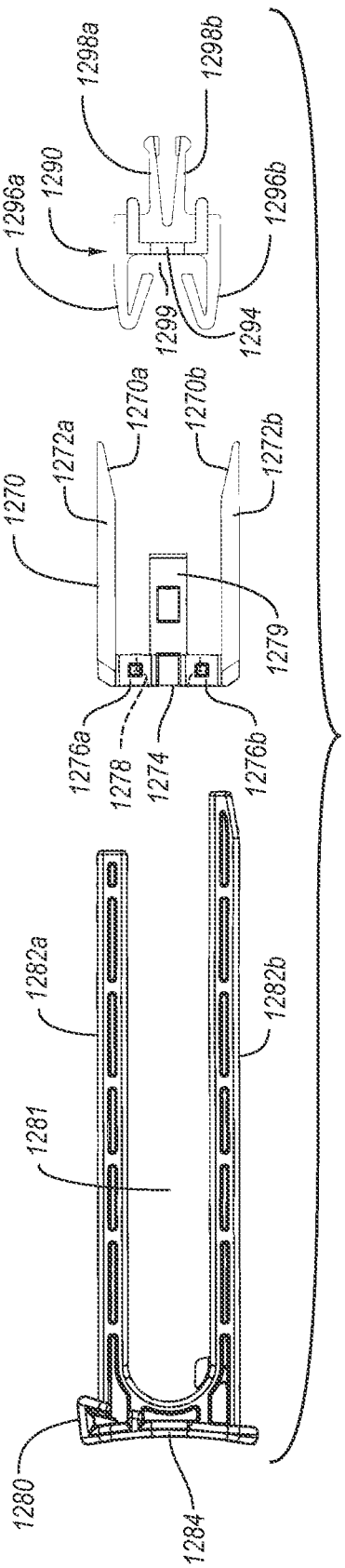


Fig. 11B

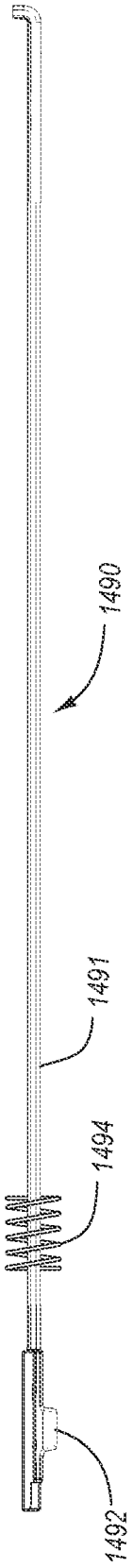


Fig. 11C

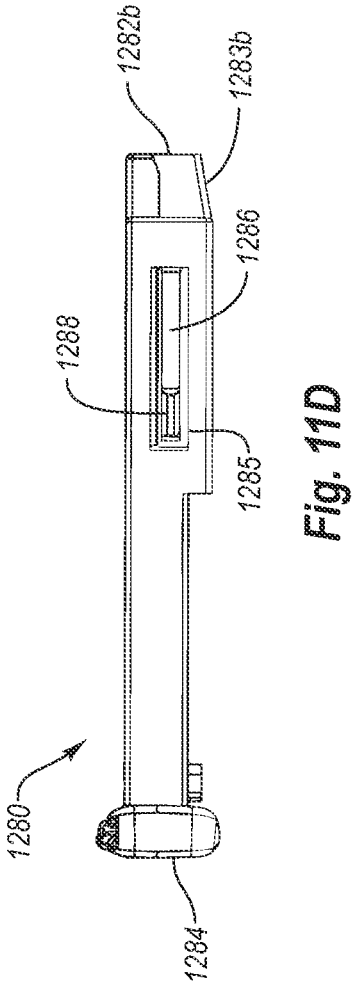


Fig. 11D

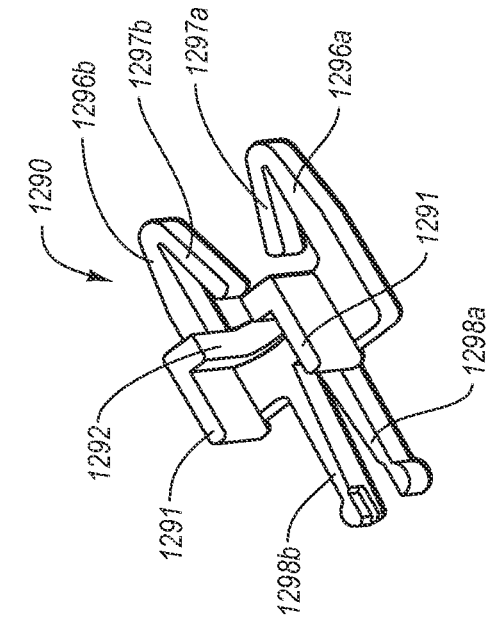


Fig. 11F

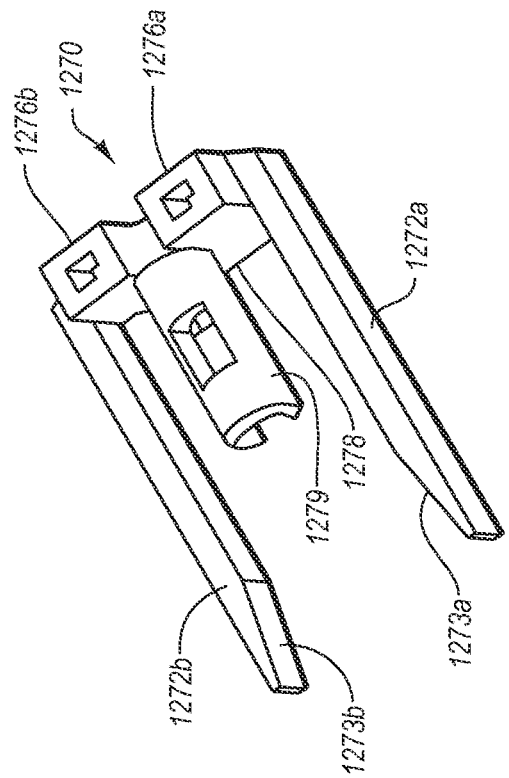


Fig. 11E

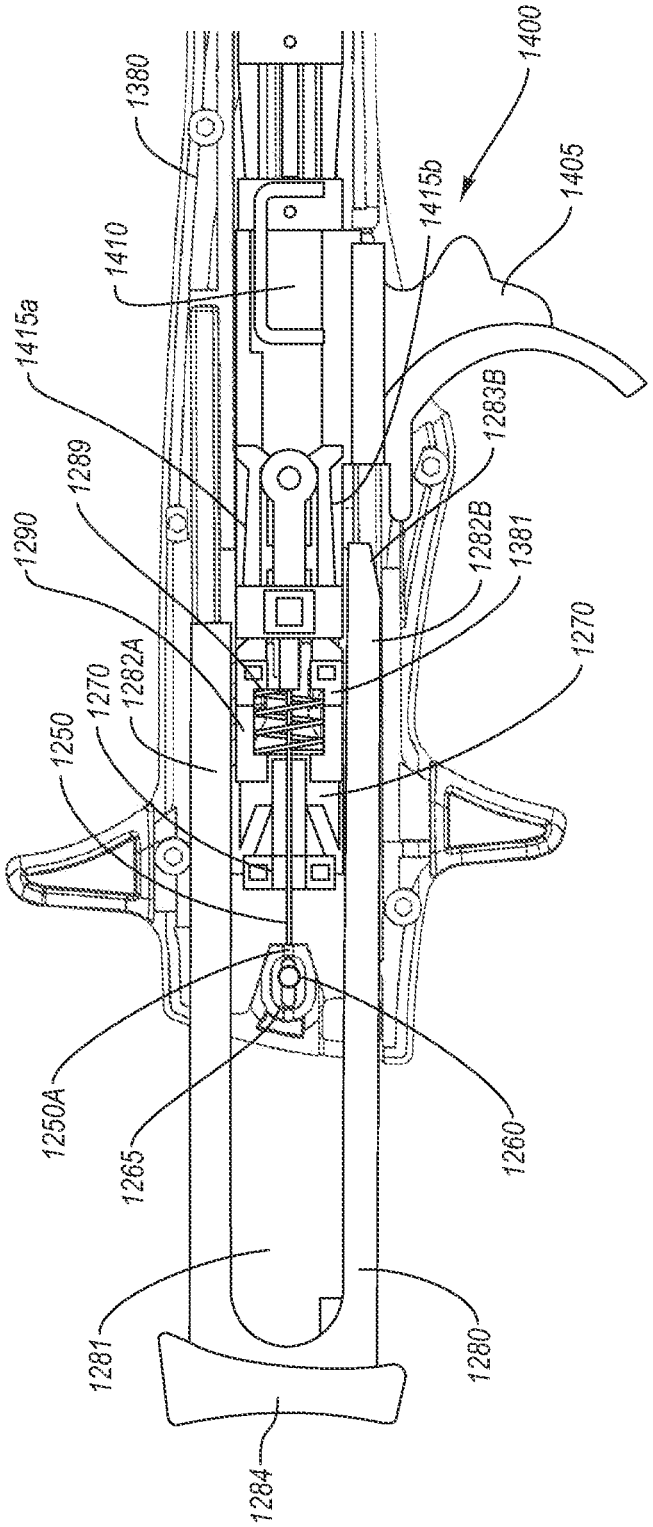

1400
1380
1405
1415b
1410
1415a
1283B
1289
1290
1282B
1381
1270
1282A
1270
1250
1250A
1265
1260
1281
1280
1284

Fig. 12

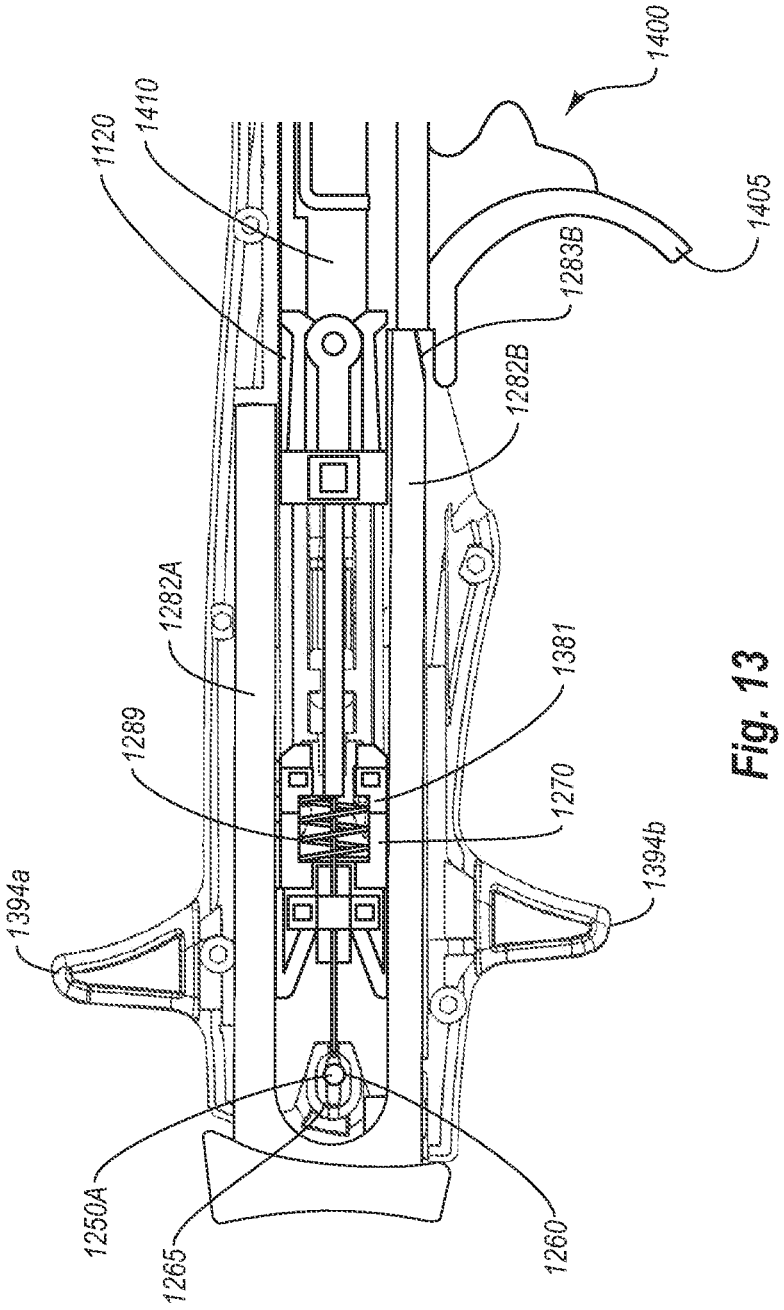

1400
1410
1120
1405
1283B
1282B
1282A
1381
1289
1270
1394b
1394a
1250A
1265
1260

Fig. 13

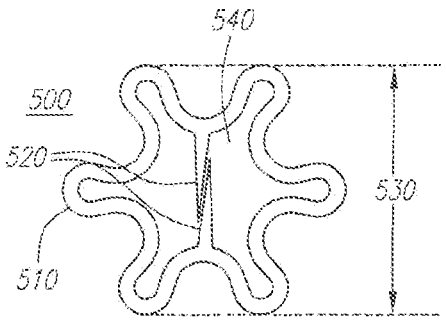


Fig. 14A

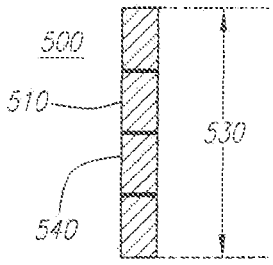


Fig. 14B

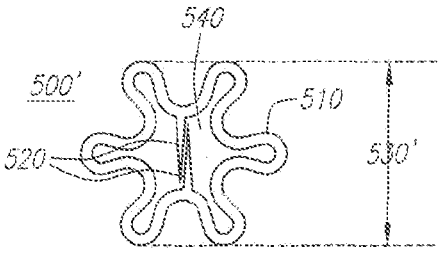


Fig. 14C

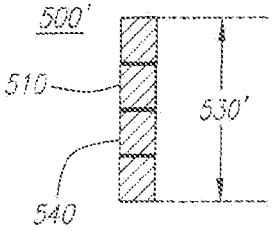


Fig. 14D

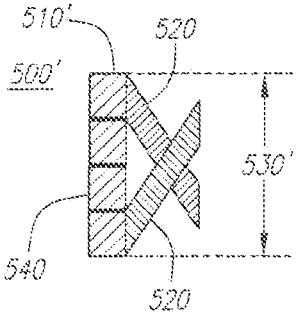


Fig. 14E

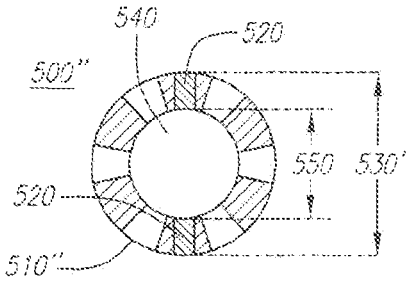


Fig. 14F

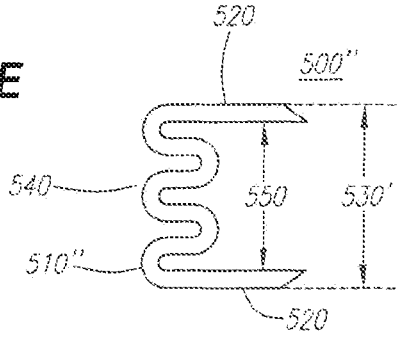


Fig. 14G

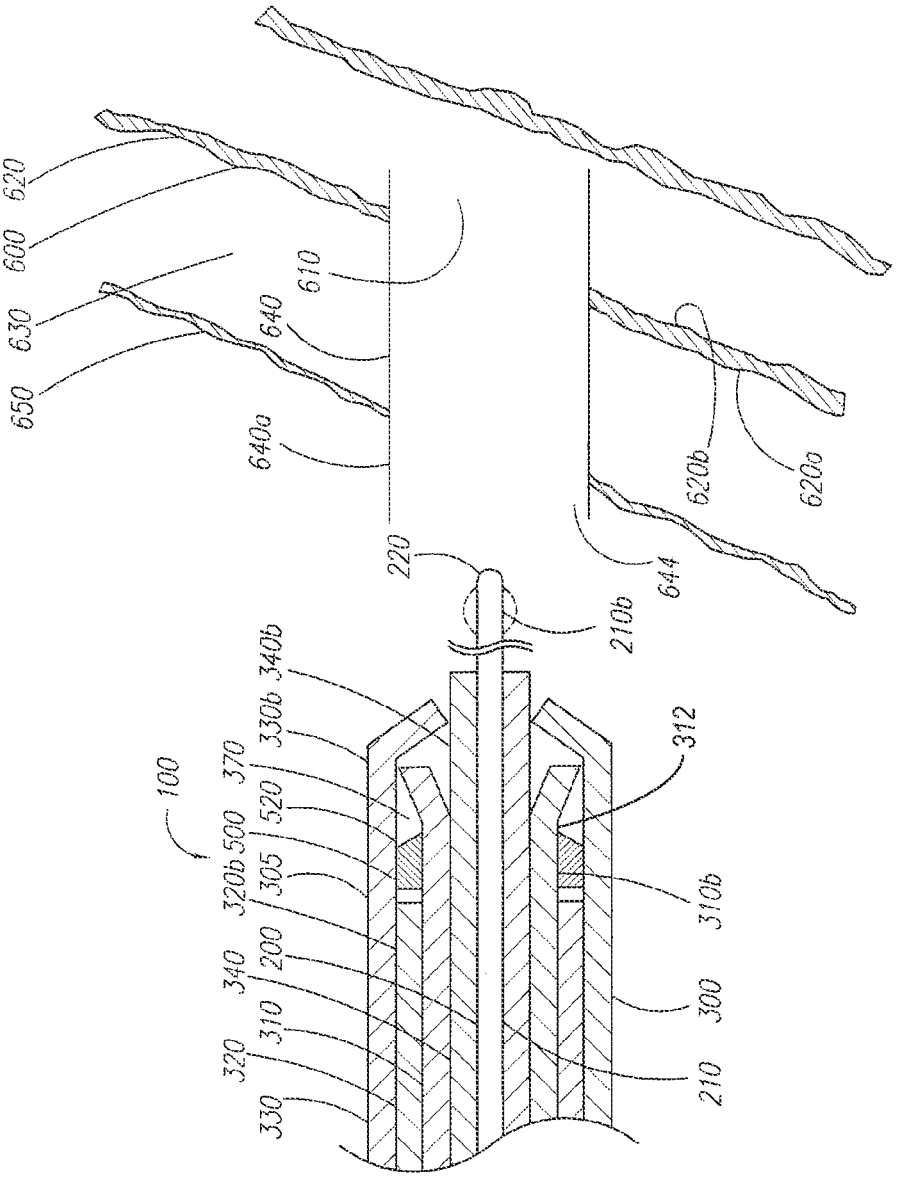

620
600
630
650
610
640
640a
620b
620a
644
220
210b
340b
330b
370
520
500
320b
305
340
200
310
320
330
312
310b
300
210
100

Fig. 15A

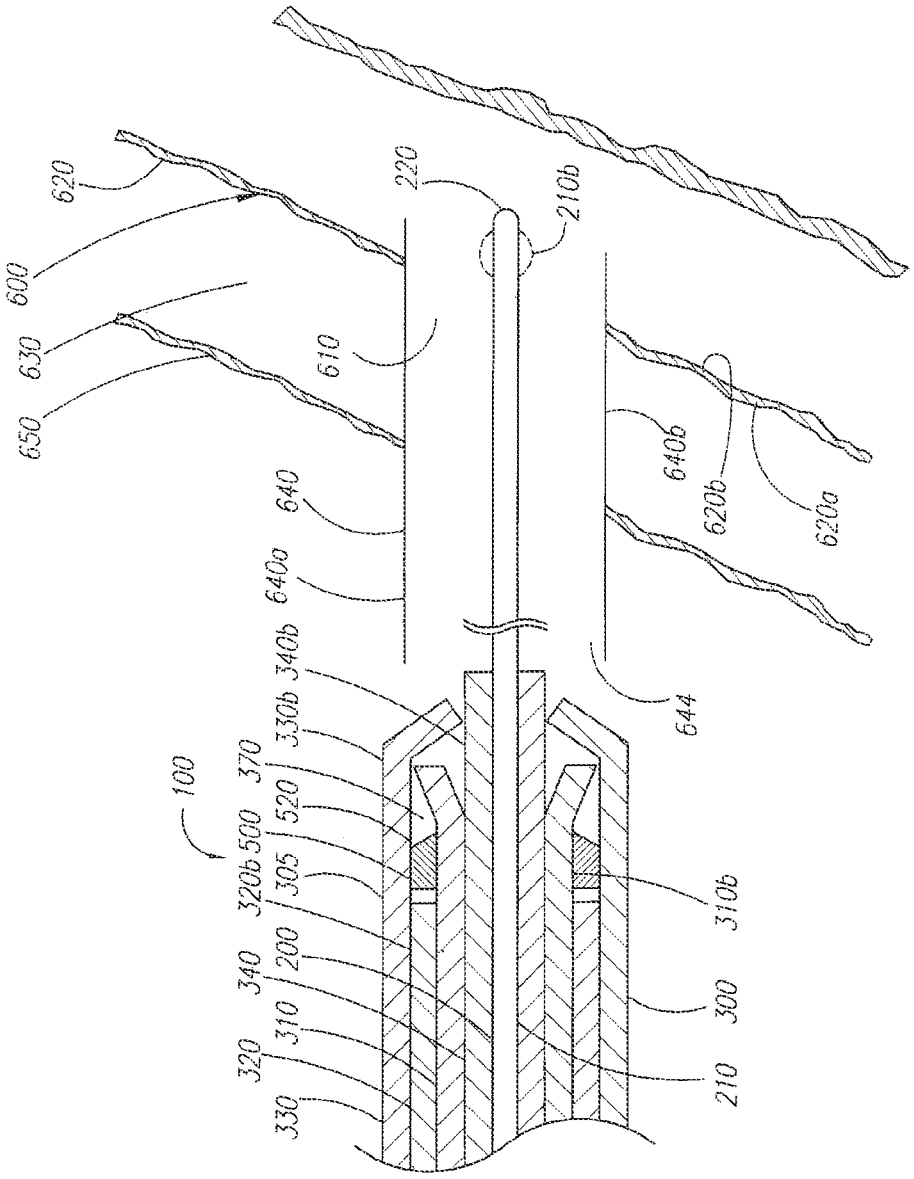

620
600
630
650
610
220
210b
640
640a
640b
620b
620a
644
340b
330b
370
100
520
500
320b
305
310b
340
200
310
300
320
330
210

Fig. 15B

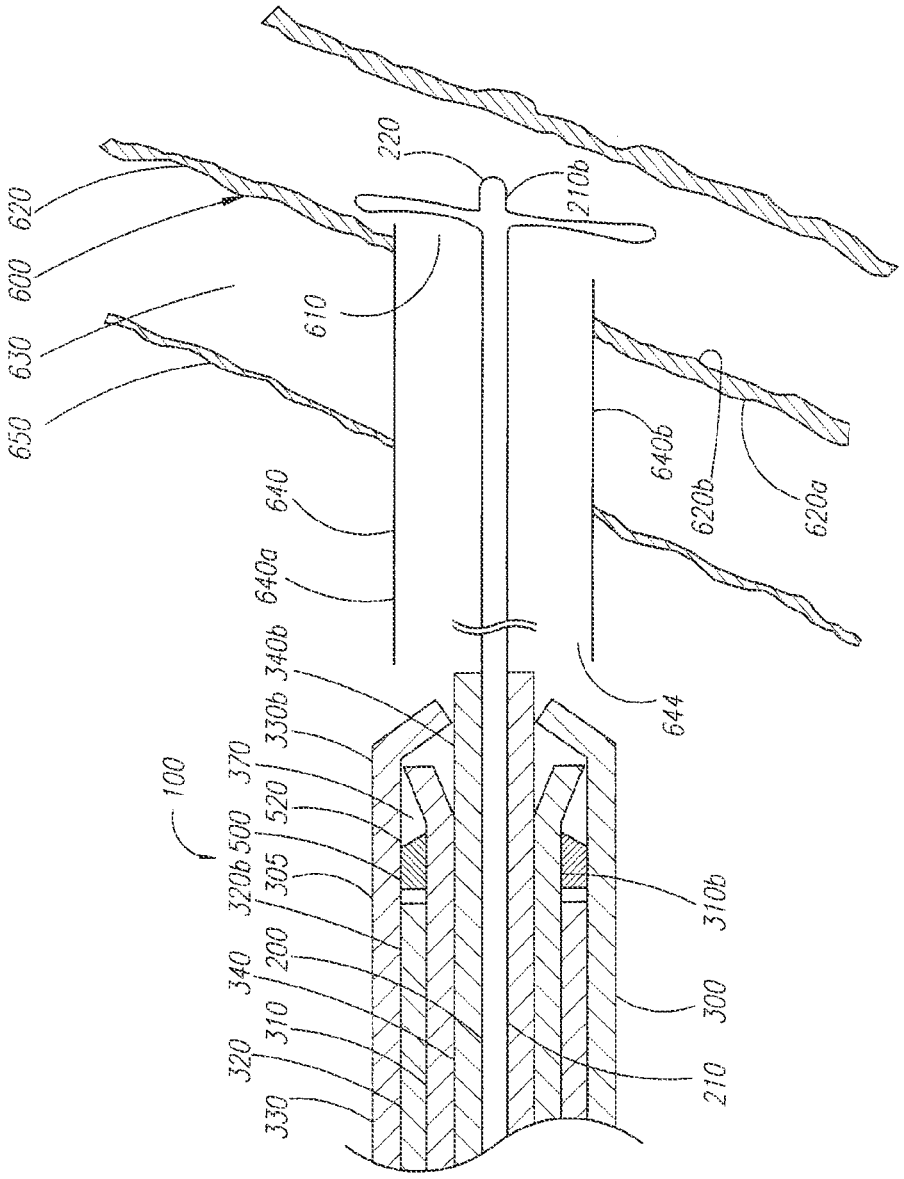

220
210b
620
600
630
650
610
640b
620b
620a
640
640a
644
340b
330b
370
520
500
320b
305
310b
100
340
200
310
300
320
330
210

Fig. 15C

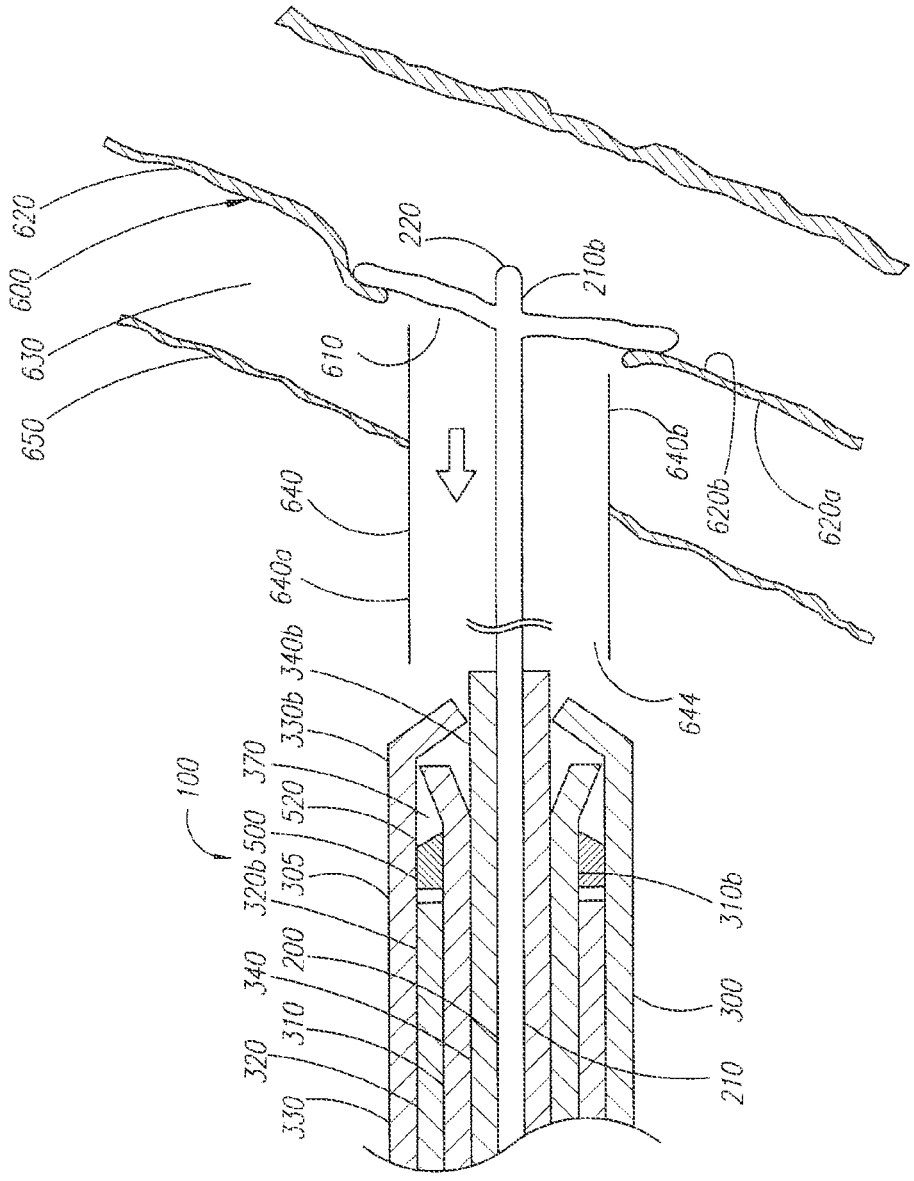

620
600
630
650
610
220
210b
640
640a
640b
620b
620a
644
340b
330b
370
520
500
320b
305
340
200
310
320
330
310b
300
210
100

Fig. 15D

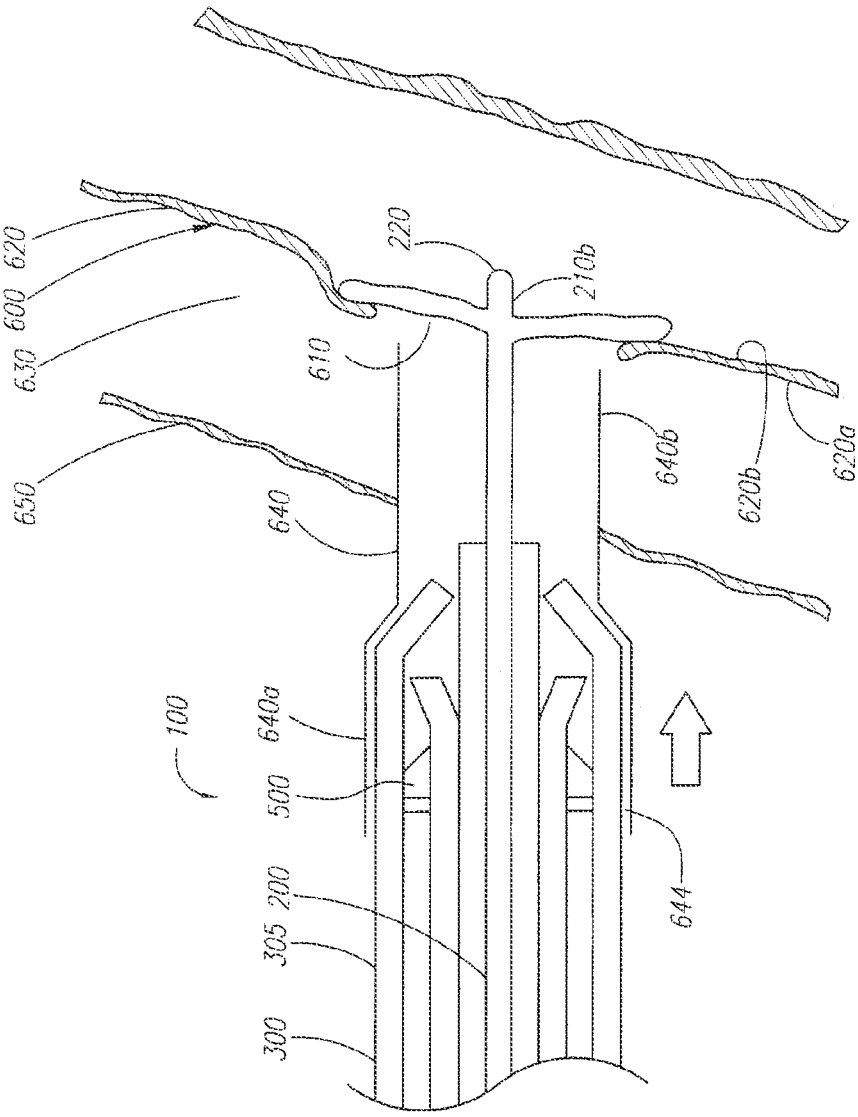

620
600
630
650
610
220
210b
640
640b
620b
620a
100
640a
500
200
305
300
644

Fig. 15E

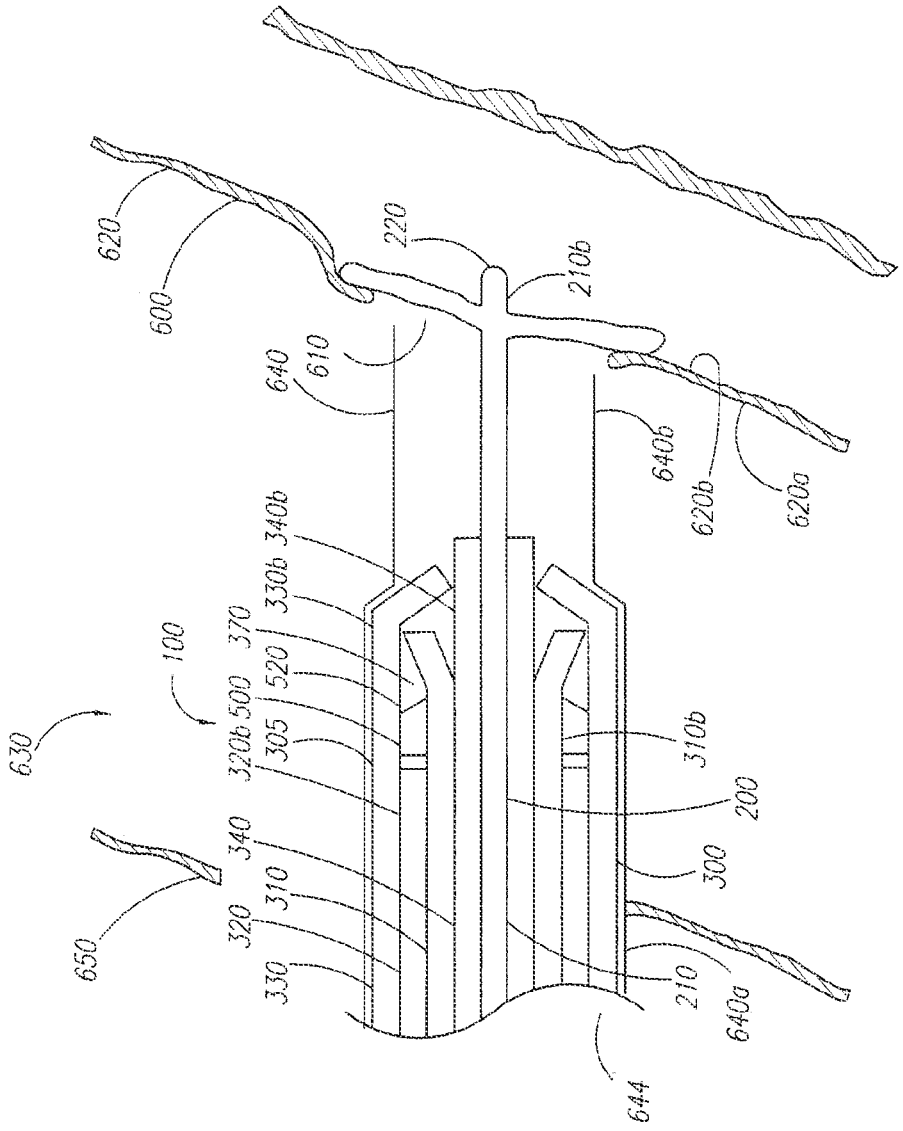

620
600
220
210b
640
610
640b
620b
620a
340b
330b
370
520
500
320b
305
310b
100
630
200
340
310
320
330
300
650
210
640a
644

Fig. 15F

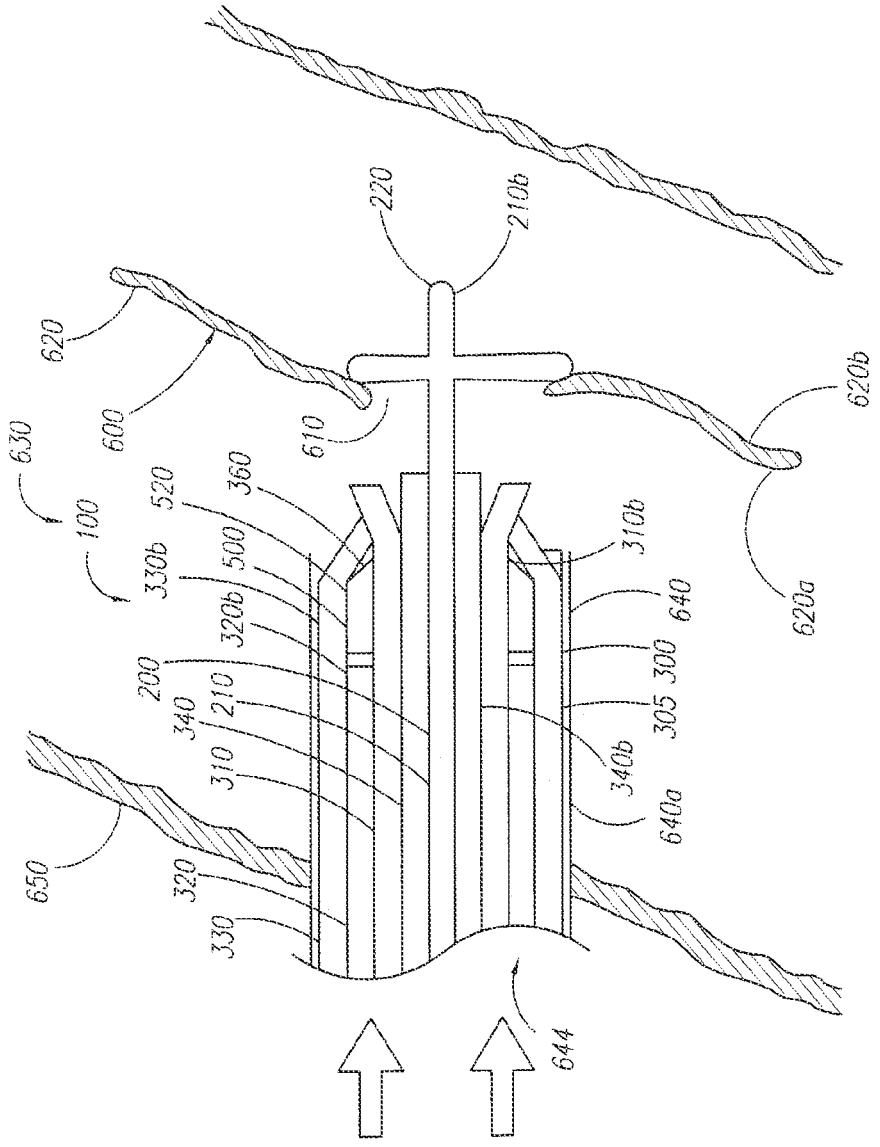

220
210b
620
600
610
620b
630
100
520
360
330b
500
310b
320b
640
620a
200
340
210
300
310
305
340b
650
640a
320
330
644

Fig. 15G

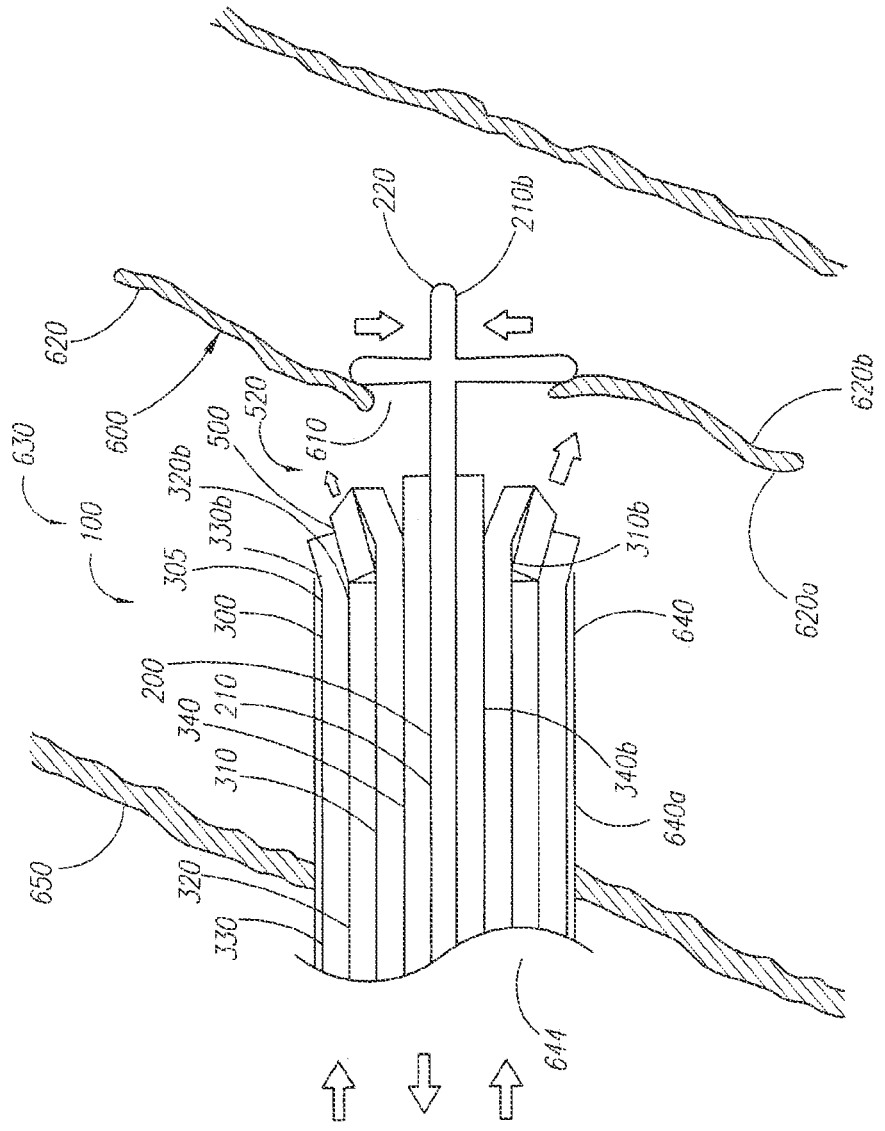

220
210b
620
600
630
100
320b
500
520
610
330b
305
300
200
340
210
310
320
330
650
620b
620a
310b
640
340b
640a
644

Fig. 15H

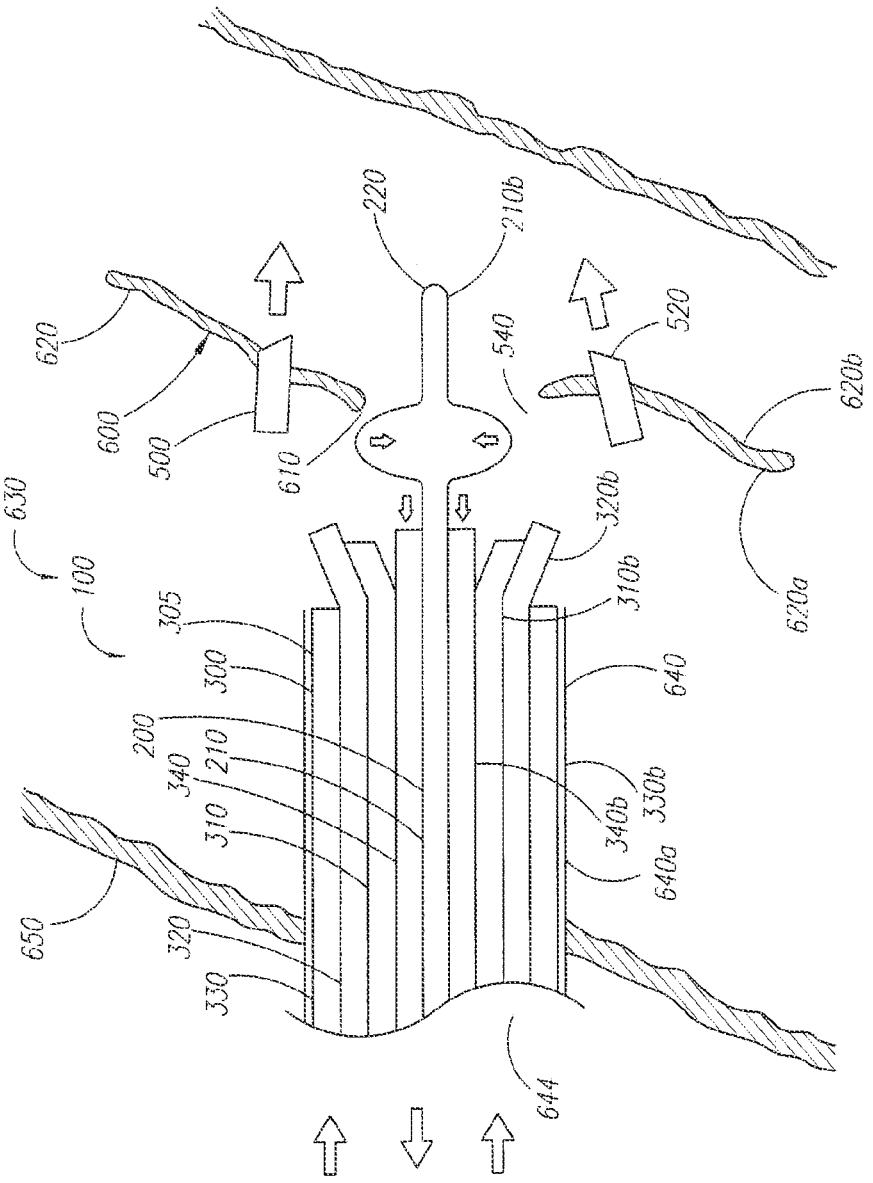

620
600
500
610
220
210b
540
520
620b
620a
630
100
305
300
200
340
210
310
320
330
650
320b
310b
640
340b
330b
640a
644

Fig. 15I

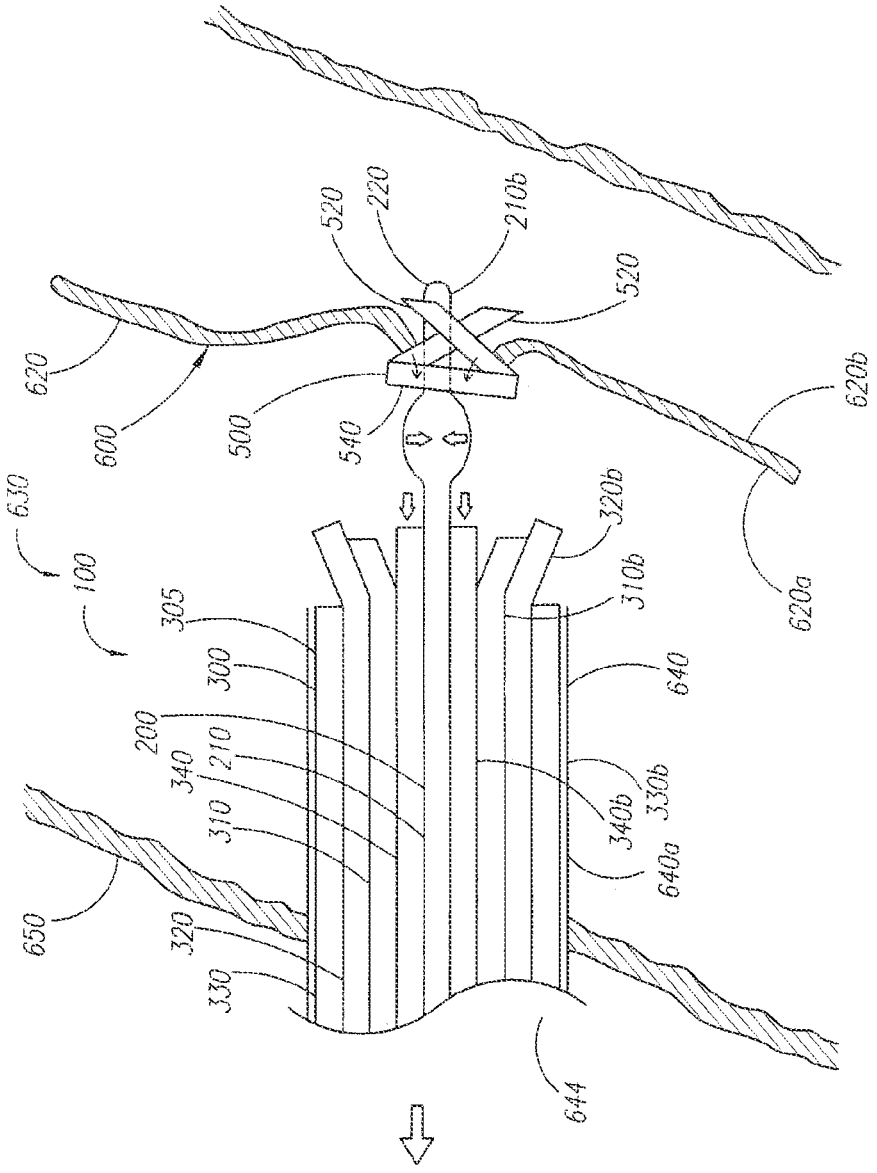

520
220
210b
520
620
600
500
540
620b
630
100
320b
310b
305
620a
300
640
200
340
210
340b
330b
310
640a
650
320
330
644

Fig. 15J

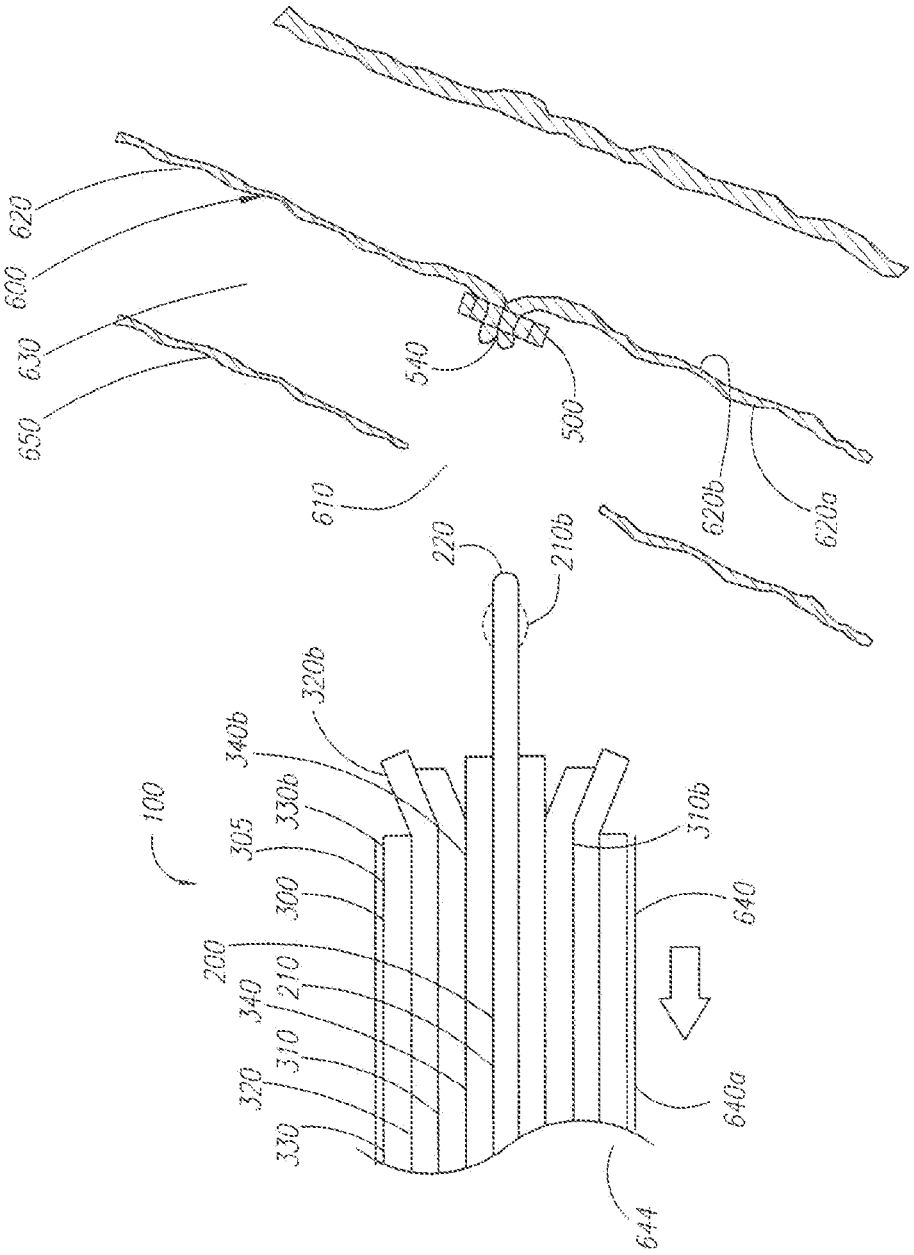

620
600
630
650
610
540
500
620b
620a
220
210b
320b
340b
330b
305
300
200
340
210
320
310
330
100
310b
640
640a
644

Fig. 15K

CLIP APPLIER AND METHODS OF USE

CROSS-REFERENCE TO RELATED APPLICATIONS

This is a continuation of U.S. patent application Ser. No. 16/144,195, filed Sep. 27, 2018, and entitled CLIP APPLIER AND METHODS OF USE, which is a continuation of U.S. patent application Ser. No. 14/732,977, filed Jun. 8, 2015 and entitled CLIP APPLIER AND METHODS OF USE, now U.S. Pat. No. 10,085,753, which is a continuation of U.S. patent application Ser. No. 13/898,202, filed May 20, 2013, and entitled CLIP APPLIER AND METHODS OF USE, now U.S. Pat. No. 9,050,068, which is a continuation of U.S. patent application Ser. No. 13/615,547, filed Sep. 13, 2012, and entitled CLIP APPLIER AND METHODS OF USE, now U.S. Pat. No. 8,518,057, which is a continuation of U.S. patent application Ser. No. 11/427,297, filed Jun. 28, 2006, and entitled CLIP APPLIER AND METHODS OF USE, now U.S. Pat. No. 8,313,497, which claims priority to and the benefit of U.S. Provisional Patent Application Ser. No. 60/696,069, filed Jul. 1, 2005, and entitled CLIP APPLIER AND METHODS OF USE, each of which is incorporated herein by reference in its entirety. This application also incorporates by reference U.S. patent application Ser. No. 10/356,214 and U.S. patent application Ser. No. 10/638,115 in their entireties.

FIELD OF THE INVENTION

The present invention relates generally to apparatus and methods for closing and/or sealing openings through tissue, and more particularly to apparatus and methods for delivering a closure element for closing a puncture in a blood vessel or other body lumen formed during a diagnostic or therapeutic procedure.

BACKGROUND OF THE INVENTION

Catheterization and interventional procedures, such as angioplasty or stenting, generally are performed by inserting a hollow needle through a patient's skin and tissue into the vascular system. A guide wire may be advanced through the needle and into the patients blood vessel accessed by the needle. The needle is then removed, enabling an introducer sheath to be advanced over the guide wire into the vessel, e.g., in conjunction with or subsequent to a dilator.

A catheter or other device may then be advanced through a lumen of the introducer sheath and over the guide wire into a position for performing a medical procedure. Thus, the introducer sheath may facilitate introducing various devices into the vessel, while minimizing trauma to the vessel wall and/or minimizing blood loss during a procedure.

Upon completing the procedure, the devices and introducer sheath would be removed, leaving a puncture site in the vessel wall. Traditionally, external pressure would be applied to the puncture site until clotting and wound sealing occur, however, the patient must remain bedridden for a substantial period of time after clotting to ensure closure of the wound. This procedure, however, may be time consuming and expensive, requiring as much as an hour of a physicians or nurses time. It is also uncomfortable for the patient, and requires that the patient remain immobilized in the operating room, catheter lab, or holding area. In addition, a risk of hematoma exists from bleeding before hemostasis occurs.

Various apparatus have been suggested for percutaneously sealing a vascular puncture by occluding the puncture site. For example, U.S. Pat. Nos. 5,192,302 and 5,222,974, issued to Kensey et al., describe the use of a biodegradable plug that may be delivered through an introducer sheath into a puncture site. Another technique has been suggested that involves percutaneously suturing the puncture site, such as that disclosed in U.S. Pat. No. 5,304,184, issued to Hathaway et al.

To facilitate positioning devices that are percutaneously inserted into a blood vessel, "bleed back" indicators have been suggested. For example, U.S. Pat. No. 5,676,974, issued to Kensey et al., discloses a bleed back lumen intended to facilitate positioning of a biodegradable plug within a puncture site. This device, however, requires that an anchor of the plug be positioned within the vessel, and therefore, may increase the risk of over-advancement of the plug itself into the vessel.

Alternatively, U.S. Pat. No. 5,674,231, issued to Green et al., discloses a deployable loop that may be advanced through a sheath into a vessel. The loop is intended to resiliently expand to engage the inner wall of the vessel, thereby facilitating holding the sheath in a desired location with respect to the vessel.

Accordingly, apparatus and methods for delivering a device for closing a vascular puncture site or other opening through tissue would be useful.

BRIEF SUMMARY

The present invention is directed toward an apparatus and method for delivering a closure element through tissue and into an opening formed in, or adjacent to, a wall of a blood vessel or other body lumen of any size. The apparatus can be configured to receive and retain the closure element so that the closure element can be disposed substantially within the apparatus. Thereby, when the apparatus is introduced via an introducer sheath, for example, the closure element can be disposed within and delivered by way of a lumen of the introducer sheath. The apparatus can also be configured to engage the blood vessel wall adjacent to the opening and to position the closure element substantially adjacent to an outer surface of the blood vessel wall adjacent to the opening.

When properly positioned, the apparatus can be activated to distally deploy the closure element. During deployment, the apparatus can be configured to substantially uniformly expand the closure element beyond a natural cross-section of the closure element such that the closure element, when deployed, can be configured to engage the blood vessel wall and/or tissue. Engaging the blood vessel wall and/or tissue, the closure element can be further configured to return to the natural cross-section. Thereby, the engaged blood vessel wall and/or tissue are drawn substantially closed and/or sealed, such that, for example, hemostasis within the opening can be enhanced.

The present invention can also accommodate for variations in the size of the physician's hand and grip by selectively reducing the distance between the devices handle portion and a portion of a triggering system usable to deploy the closure element. The triggering system of the apparatus can at least partially move a trigger extension graspable by a physician or clinician as a locator assembly locates the blood vessel wall prior to deploying the closure element. This partial movement reduces the gap between the trigger extension and the handle portion. In this manner, a physician or clinician does not need to stretch uncomfortably to

position a thumb or finger on the trigger extension, grasping the handle portion, and maintaining the device in the desired orientation relative to the tissue and/or the puncture site.

An apparatus of the present invention is usable to deliver a closure element to an opening formed in a wall of a body lumen. The apparatus can include a locator assembly having a distal end region configured to extend into the opening and selectably contact the wall of the body lumen and a proximal end configured to cooperate with a movable plunger. A carrier assembly can be coupled with the locating assembly, the carrier assembly retaining the closure element in a substantially tubular configuration within the carrier assembly. A triggering system can also cooperate with the locator assembly, the triggering system can move toward the distal end region of the locator assembly as the movable plunger moves toward the distal end region. In one configuration, the triggering system can move toward the distal end region substantially simultaneously with the distal end region transitioning from the unexpanded state to the expanded state.

The locator assembly of the apparatus can further include a locator control system coupled to a proximal end region of the locator assembly. This locator control system can be configured to selectively control the distal end region of the locator assembly between the expanded state and the unexpanded state. In one configuration, the locator control system can include a tubular body block mounted to a tubular member, a spring retainer receiving a portion of the tubular body block, and a movable plunger slidably cooperating with the tubular body block and the tubular member.

The present invention can also provide a stable base upon which the physician or clinician can move the device or apparatus as the closure element is positioned and deployed. In one configuration, the stable base is formed from the handle portion having two graspable portions: a shaped grasping portion and an elongated grasping portion. The shaped grasping portion can be configured to receive at least a thumb or finger of the physician. A portion of the handle portion can have a curved profile to enable a portion of the handle to fit comfortably within a user's hand while the hand is rested on a patient during the procedure to provide stability during use of the device and function as a based or pivot point for moving the remainder of the device or apparatus.

Other aspects and features of the present invention will become apparent from consideration of the following description in conjunction with the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

In order to describe the manner in which the above-recited and other advantages and features of the invention can be obtained, a more particular description of the invention briefly described above will be rendered by reference to specific embodiments thereof which are illustrated in the appended drawings. Understanding that these drawings depict only typical embodiments of the invention and are not therefore to be considered to be limiting of its scope, the invention will be described and explained with additional specificity and detail through the use of the accompanying drawings.

FIG. **1**A illustrates an assembly view of the components of one embodiment according to the present invention for closing openings in blood vessel walls.

FIG. **1**B illustrates another assembly view of the components of one embodiment according to the present invention for closing openings in blood vessel walls.

FIG. **2** illustrates the assembled carrier assembly and triggering assembly of the apparatus shown in FIGS. **1**A and **1**B.

FIG. **3**A illustrates a close-up view of the proximal end of the apparatus shown in FIG. **2**.

FIG. **3**B illustrates a close-up view of the distal end of the apparatus shown in FIG. **2** in an unexpanded state.

FIG. **3**C illustrates a close-up view of the distal end of the apparatus shown in FIG. **2** in an expanded state.

FIG. **4** illustrates the apparatus of FIG. **2** after distal advancement of the locator assembly, the triggering system and the carrier assembly.

FIG. **5** illustrates a close-up view of the triggering system and carrier assembly of the apparatus shown in FIG. **4**.

FIG. **6** illustrates the apparatus of FIG. **1**A-**1**B after the clip has been released to close the opening in the tissue.

FIG. **7** illustrates a close-up view of the triggering system and carrier assembly of the apparatus of FIG. **1**A-**1**B after the clip has been released to close the opening in the tissue.

FIG. **8** illustrates a cross-sectional schematic view of the distal end of the apparatus shown in FIG. **4** as assembled for deployment.

FIG. **9** illustrates a plan view of an alternative embodiment of an apparatus for closing openings in tissue in accordance with the present invention.

FIG. **10** illustrates a portion of a housing half of the alternative embodiment of FIG. **9**, illustrating the functional components thereof.

FIG. **11**A illustrates a portion of a housing half of the alternative embodiment of FIG. **9**, without certain functional components.

FIG. **11**B illustrates a portion of a locator control system of the alternative embodiment of FIG. **9**.

FIG. **11**C illustrates a portion of a locator release system of the alternative embodiment of FIG. **9**.

FIG. **11**D illustrates a side view of a plunger of the locator control system of FIG. **11**B of the alternative embodiment of FIG. **9**.

FIG. **11**E illustrates a perspective view of a tubular body block of the locator control system of FIG. **11**B of the alternative embodiment of FIG. **9**.

FIG. **11**F illustrates a perspective view of a spring retainer of the locator control system of FIG. **11**B of the alternative embodiment of FIG. **9**.

FIG. **12** illustrates a close-up cross-sectional view of the proximal end of the apparatus shown in FIG. **9**, illustrating the initial position of the locator control system.

FIG. **13** illustrates a close-up cross-sectional view of the proximal end of the apparatus shown in FIG. **9**, illustrating the final position before clip release of the locator control system.

FIGS. **14**A-**14**G illustrate various embodiments of closure elements that can be utilized with the apparatus of the present invention.

FIGS. **15**A-K illustrate various steps in the deployment of embodiments of the present invention.

It should be noted that the figures are not drawn to scale and that elements of similar structures or functions are generally represented by like reference numerals for illustrative purposes throughout the figures. It also should be noted that the figures are only intended to facilitate the description of embodiments of the present invention.

DETAILED DESCRIPTION

The embodiments described herein extend to methods, systems, and apparatus for closing and/or sealing openings

in a blood vessel or other body lumen formed during a diagnostic or therapeutic procedure. The apparatuses of the present invention are configured to deliver a closure element through tissue and into an opening formed in and/or adjacent to a wall of a blood vessel or other body lumen.

Since current apparatuses for sealing openings formed in blood vessel walls can snag tissue adjacent to the openings during positioning and may not provide an adequate seal, an apparatus that is configured to prevent inadvertent tissue contact during positioning and to engage tissue adjacent to the opening can prove much more desirable and provide a basis for a wide range of medical applications, such as diagnostic and/or therapeutic procedures involving blood vessels or other body lumens of any size. Further, since current apparatuses for sealing openings formed in blood vessel walls are typically one-size and do not provide a mechanism to accommodate for variations in the size or configuration of the physician's or clinician's hands, an apparatus that varies its operational configuration to accommodate for physician or clinician hand sizes can prove much more desirable and beneficial to the medical arts. These results, whether individually or collectively, can be achieved, according to one embodiment of the present invention, by employing an apparatus as shown in the figures and described in detail below.

As will be discussed in more detail below, the apparatuses of the present invention are configured to deliver a closure element through tissue and into an opening formed in and/or adjacent to a wall of a blood vessel or other body lumen. The apparatus can be configured to receive and retain a closure element such that the closure element can be disposed substantially within the apparatus. The apparatuses in accordance with the present invention generally include a handle portion having a proximal end and a distal end, a locator and clip delivery assembly extending from the distal end of the handle portion, and a locator actuator disposed at the proximal end of the handle portion.

Referring now to FIG. **1**, an exploded assembly view of one closure apparatus is shown in accordance with the present invention. As shown in FIG. **1**, the apparatus can include a housing that receives or retains a plurality of tubular members. The tubular members can be concentrically disposed within the housing of the device, with each tubular member having an associated block member fixedly attached to the proximal end thereof. The block members can be configured to interact with each other as well as with features of the housing, such as through movement of a triggering system. The interaction of the tubular members, the blocks, and the triggering system will be described in greater detail below. Also described below will be additional details regarding the handle portion of the housing and the manner by which the movement of the tubular members and the triggering system results in variation of the devices operational configuration to accommodate for physician or clinician hand sizes.

With continued reference to FIGS. **1**A and **1**B, apparatus **100** can be provided as one or more integrated components and/or discrete components that may be retained within a housing **102**, having a housing top half **380***c* and a housing bottom half **380***d* (not shown). For example, apparatus **100** can include a locator assembly **110** and a carrier assembly **120**. For purposes of illustration, locator assembly **110** and carrier assembly **120** are shown in FIG. **1**A as comprising substantially separate assemblies. As desired, however, locator assembly **110** and carrier assembly **120** each can be provided, in whole or in part, as one or more integrated assemblies.

Turning to FIGS. **1**A-**2**, **4**, and **6**, the assembly **110** can include a locator assembly **200**. This locator assembly **200** can include flexible or semi-rigid tubular body **210** (such as an elongate rail) with a longitudinal axis. Tubular body **210** can have a proximal end region **210***a* and a distal end region **210***b* and can include a predetermined length and a predetermined outer cross-section, both of which can be of any suitable dimension. Distal end region **210***b* of locator assembly **200**, as shown in more detail in FIGS. **3**B and **3**C, can include a substantially rounded, soft, and/or flexible distal end or tip **220** to facilitate advancement and/or retraction of distal end region **210***b* into a blood vessel or other opening in tissue. As desired, a pigtail (not shown) may be provided on tip **220** to further aid atraumatic advancement of distal end region **210***b*.

Distal end region **210***b* of locator assembly **200** is selectably controllable between an unexpanded state, as shown in FIG. **3**B, and an expanded state, as shown in FIG. **3**C. As shown in FIG. **3**B, when an expansion end **230** is in an unexpanded state, substantially flexible members **232** are substantially axially aligned with locator assembly **200**. Alternatively, when expansion end **230** is in an expanded state, substantially flexible members **232** are flexed outward.

Returning to FIG. **1**B, a control member **250**, such as a rod, wire, or other elongate member, may be moveably disposed within a lumen (not shown) formed by tubular body **210** and extending substantially between the proximal end region **210***a* and distal end region **210***b*. Control member **250** may have proximal end region **250***a* coupled with a control block **260**, and a distal end region **250***b* coupled with distal end region **210***b* of locator assembly **200**, expansion end **230**, and/or the movable end regions of substantially flexible members **232**. Control block **260** may be formed of a metal or rigid plastic in a tubular shape, and may be adapted to be retained in control block cavity **265** formed on the internal surface of housing bottom half **380***d*, to thereby maintain control block **260** in a substantially fixed position relative to the housing **380**. By moving tubular body **210** axially relative to control member **250**, the distal end region **210***b*, expansion end **230**, and/or the substantially flexible members **232** (FIG. **3**B), are selectively transitioned between the unexpanded and expanded states.

With reference to FIG. **3**A, a tubular body block **270** having proximal groove **271** may be formed on proximal end **210***a* of tubular body **210**. Tubular body block **270** may be formed of metal, rigid plastic, or other substantially rigid material and may be formed integrally with or attached securely to tubular body **210**. Proximal groove **271** and the proximal end of tubular body block **270** may have a shape adapted to cooperate with a pair of tabs **279***a*, **279***b* formed on a locator assembly block **280**, whereby tubular body block **270** may be maintained in a fixed axial relationship with the locator assembly block **280**. In this way, tubular body block **270** and tubular body **210** (FIG. **1**B) may advance distally by distal advancement of locator assembly block **280**.

A locator assembly spring **290** may be located coaxially with and may substantially surround a portion of tubular body block **270**. Locator assembly spring **290** may be located between and in contact with the distal side of two of tabs **279***a*, **279***b* formed on locator assembly block **280** and the proximal side of locator assembly spring stop **381** formed on the inner surface of housing bottom half **380***d*. The locator assembly spring **290** so located may provide a force biasing to locator assembly block **280** in the proximal direction relative to housing **380**.

Locator assembly block **280** may be formed of metal, plastic, or other rigid material. A function of locator assembly block **280** may be to allow a user to apply a force causing distal movement of tubular body **210** (FIG. **1**) relative to control member **250** causing locator assembly **200** (FIG. **2**) to transition from the unexpanded state to the expanded state. Slot **281** may be formed in the proximal end of locator assembly block **280**. Slot **281** may have a size sufficient to accommodate control block **260** and control block cavity **265**, and to allow locator assembly block **280** to travel axially relative to housing **380**. As shown in FIG. **1**, the distal end of locator assembly block **280** may include a pair of distally extending legs **282***a-b*, with each of legs **282***a-b* having a ramp **283***a-b* on its inward facing surface. Finally, the locator assembly block **280** may have a pair of distally extending release tabs **284***a-b*, each of release tabs **284***a-b* having a detent **285***a-b*.

As shown in FIGS. **2-3**A, locator assembly block **280** may be slidably received and retained within grooves formed in the proximal end of housing **380**, with the proximal end of locator assembly block **280** extending from the proximal end of housing **380**. Control block **260** and control block cavity **265** may be located in slot **281** formed in the proximal end of locator assembly block **280**.

To release locator assembly **200**, and enable it to slidably move within the grooves formed in the proximal end of the housing **380** and allow locator assembly **200** to transition from its expanded state to its unexpanded state, the apparatus **100** can include a locator release system **490** (FIG. **1**A). Turning to FIG. **1**A, locator release system **490** of the apparatus **100** may include locator release rod **491** having release tab spacer block **492** formed on its proximal end. Locator release rod **491** and release tab spacer block **492** may be received and retained in a groove formed on the interior surface of housing bottom half **380***d*. Release tab spacer block **492** may be integrally formed with or attached to the proximal end of locator release rod **491** and may be formed of metal, plastic, or other rigid material. Release tab spacer block **492** may have a shape and size adapted to fit between release tabs **284***a-b* formed on locator assembly block **280**, thereby biasing release tabs **284***a-b* outward and causing outward facing detents **285***a-b* to engage retaining grooves **286***a-b* (FIG. **1**B) formed on the interior of housing **380**. As long as detents **285***a-b* are thus engaged with retaining grooves **286***a-b* in housing **380**, locator assembly block **280** is held in an axial position against the spring force imparted in the proximal direction by locator assembly spring **290**.

With continued reference to FIG. **1**A, the distal end of locator release rod **491** may have an engagement member **493** that comprises an inward bend on the distal end of locator release rod **491**. As described more fully below, engagement member **493** on locator release rod **491** may be positioned within the apparatus **100** such that when closure element **500** is delivered, engagement member **493** is engaged and caused to move axially in the distal direction, thereby disengaging release tab spacer block **492** from locator assembly block **280** and causing locator assembly **200** simultaneously to transition from an expanded state to an unexpanded state.

Returning to FIG. **1**A, the carrier assembly **120** may be coupled with, and slidable relative to, locator assembly **200**. Carrier assembly **120** may be configured to receive and retain closure element **500**, which may be disposed substantially within carrier assembly **120**. Carrier assembly **120** may be further configured to position closure element **500** substantially adjacent to an opening to be closed, and to deploy closure element **500**. Upon being deployed, closure element **500** can maintain a reduced cross-section but may also temporarily and substantially uniformly expand beyond the natural cross-section of closure element **500**. In either case, closure element **500**, when deployed, can engage an amount of the blood vessel wall and/or tissue adjacent to the opening. Thereafter, closure element **500** may be configured to return to the natural cross-section, optionally substantially uniformly, such that the blood vessel wall and/or tissue are drawn substantially closed and/or sealed.

As shown in FIG. **1**A, carrier assembly **120** may include a tube set **305** of at least one tubular member. For instance, the illustrated tube set can include carrier member **310**, pusher member **320**, cover member **330**, and support member **340**, also shown in FIG. **8**. Carrier member **310**, pusher member **320**, cover member **330**, and support member **340** may be provided as a plurality of nested, telescoping members with a common longitudinal axis. Carrier member **310** may be configured to receive and support closure element **500**. While being disposed on carrier member **310**, closure element **500** may be deformed from the natural, planar configuration to form a substantially tubular closure element **500"**, as shown in FIGS. **14**A-**14**G, and as described herein.

Returning to FIG. **1**A, carrier member **310** may include proximal end region **310***a* and distal end region **310***b*. Carrier member **310** may also define lumen **314**, which may extend substantially between proximal end region **310***a* and distal end region **310***b* and configured to slidably receive at least a portion of tubular body **210** of locator assembly **200** and/or support member **340**. Although the exterior cross-section of the carrier member **310** may be substantially uniform, the distal end region **310***b* of carrier member **310** may have a cross-section that increases distally, as illustrated in FIG. **1**A, for substantially uniformly expanding substantially tubular closure element **500** (FIG. **14**G) beyond natural cross-section **530** (FIG. **14**A) of closure element **500"** when substantially tubular closure element **500"** is deployed. Alternatively, distal end region **310***b* may be formed with a uniform cross-section to deploy closure element **500** without cross-sectional expansion.

Pusher member **320** may have proximal end region **320***a* and distal end region **320***b*. Pusher member **320** may be coupled with, and slidable relative to, carrier member **310**. Pusher member **320** may include a predetermined length and a predetermined cross-section, both of which can be of any suitable dimension and can be configured to slidably receive carrier member **310** such that distal end region **320***b* of pusher member **320** may be offset proximally from distal end region **310***b* of carrier member **310**. As desired, the predetermined length of pusher member **320** may be substantially equal to a predetermined length of carrier member **310**. A predetermined length of pusher member **320** may be less than a predetermined length of carrier member **310** such that carrier member **310** and pusher member **320** may at least partially define a space **360** (FIG. **8**) distal to distal end region **320***b* of pusher member **320** and along the periphery of carrier member **310**.

Pusher member **320** may be substantially tubular and can define a lumen **324** that may extend substantially between proximal end region **320***a* and distal end region **320***b* and configured to slidably receive at least a portion of the carrier member **310**. The cross-section of pusher member **320** may be substantially uniform and distal end region **320***b* of pusher member **320** can comprise one or more longitudinal extensions **325**, which may extend distally from pusher member **320** and along the periphery of carrier member **310**. Longitudinal extensions **325** may be biased such that lon-

gitudinal extensions **325** extend generally in parallel with the common longitudinal axis of carrier assembly **120**. Longitudinal extensions **325** may be sufficiently flexible to expand radially, and yet sufficiently rigid to inhibit buckling as distal end region **320***b* is directed distally along carrier member **310** and engages the distally-increasing cross-section of distal end region **310***b* of carrier member **310** to deploy closure element **500**

Cover member **330** may be configured to retain closure element **500**, in its generally tubular configuration, substantially within the carrier assembly **120** prior to deployment. Being coupled with, and slidable relative to, pusher member **320**, cover member **330** has proximal end region **330***a* and distal end region **330***b*, a predetermined length and a predetermined cross-section, both of which can be of any suitable dimension. Cover member **330** may be formed as a substantially rigid, semi-rigid, or flexible tubular member with an inner periphery and an outer periphery, and may define a lumen **334**. Lumen **334** may extend substantially between proximal and distal end regions **330***a*, **330***b* of cover member **330** and may be configured to slidably receive at least a portion of pusher member **320**. When cover member **330** is properly positioned within carrier assembly **120**, as schematically illustrated in FIG. **15**A, distal end region **330***b* may be configured to extend over the space **360**, thereby defining annular cavity **370** for receiving and retaining substantially tubular closure element **500**".

The cross-section of cover member **330** may be substantially uniform, and distal end region **330***b* of cover member **330** may comprise one or more longitudinal extensions **335**, which extend distally from cover member **330** and along an outer periphery of pusher member **320**, as shown in FIG. **8**. Although longitudinal extensions **335** can extend generally in parallel with the longitudinal axis of the tube set **305**, longitudinal extensions **335** may be biased such that the plurality of longitudinal extensions **335** extend substantially radially inward. Thereby, longitudinal extensions **335** may at least partially close lumen **334** substantially adjacent to distal end region **330***b* of cover member **330**.

With reference to FIGS. **1**B and **15**A, to permit closure element **500** to be deployed from annular cavity **370**, longitudinal extensions **335** may be sufficiently flexible to expand radially to permit distal end region **310***b* of carrier member **310** to move distally past cover member **330** to open annular cavity **370** such that distal end region **330***b* no longer extends over the space **360**.

When carrier assembly **120** is assembled as a plurality of nested, telescoping members, as shown in FIGS. **2** and **8**, carrier member **310** is at least partially disposed within, and slidable relative to, a lumen of pusher member **320**, and support member **340** is slidably relative to pusher member **310**. Pusher member **320**, in turn, is at least partially disposed within, and slidable relative to, lumen **334** of cover member **330**. To couple carrier assembly **120** with locator assembly **200**, tubular body **210** of locator assembly **200** may be at least partially disposed within, and slidable relative to, lumen **314**. The longitudinal axis of locator assembly **200** may be substantially in axial alignment with the common longitudinal axis of carrier member **310**, pusher member **320**, and cover member **330**.

The apparatus **100** may also include support member **340** as shown in FIG. **1**A. Support member **340** may be configured to slidably receive tubular body **210** of locator assembly **200** and provide radial support for distal end region **210***b* of tubular body **210** when locator assembly **200** is coupled with the carrier assembly **120**. Carrier assembly **120** can advantageously include support member **340**, for example, if tubular body **210** is not sufficiently rigid or under other circumstances in which support for tubular body **210** might be desirable. It also will be appreciated that support member **340** may also be configured to inhibit longitudinal extensions **335**, which extend from distal end region **330***b* of cover member **330**, from expanding prematurely when closure element **500** is deployed. If longitudinal extensions **335** were to expand prematurely, they may become hung up on an introducer sheath or other delivery member (if an introducer sheath or delivery member is used), the tissue, or the wall of the blood vessel. This may interfere with the proper advancement or other movement of cover member **330** and carrier assembly **120**.

Support member **340** may be formed as a substantially rigid, semi-rigid, or flexible tubular member, and may include proximal end region **340***a* and distal end region **340***b*. Having an outer periphery, support member **340** may define lumen **344**, extending substantially between proximal end region **340***a* and distal end region **340***b* and configured to slidably receive and support at least a portion of tubular body **210** of locator assembly **200**. Support member **340**, in turn, can be at least partially slidably disposed within lumen **314** of carrier member **310** such that tubular body **210** of locator assembly **200** is coupled with, and slidable relative to, carrier member **310** in the manner described in more detail above.

Support member **340** may have a predetermined length and a predetermined cross-section, both of which can be of any suitable dimension, and may have a substantially uniform cross-section. Although shown and described as being substantially separate for purposes of illustration, it will be appreciated that carrier member **310**, pusher member **320**, cover member **330**, and/or support member **340** may be provided, in whole or in part, as one or more integrated assemblies.

With reference to FIG. **8**, support member **340** may also include a distal end that is blunt, rounded and/or includes a radius or curved portion that may prevent and/or eliminate damage to tubular body **200** as tubular body is moved with respect to support member **340**. In some cases during deployment, as discussed in more detail below, tubular body **200** may be inserted into a lumen of an introducer at such an angle as to require tubular body **200** to flex with respect to tube set **305** as much as between about 0 degrees and 90 degrees, preferably between about 10 degrees and 90 degrees and more preferably between 30 degrees and 60 degrees, for example when used in conjunction with a femoral artery. The above-described distal end of the distal end region **340***b* prevents and/or eliminates damage to tubular body **200** that may result from a sharp edge pressed along tubular body **200** during advancement of tube set **305**, and more particularly, support member **340** and the distal end of the distal end region **340***b*.

Illustratively, the radii of the distal end of the support member **340** can have various sizes and configurations. In one configuration, the distal end radii can be about 0.002 inches. In still another configuration, the distal end radii can be about 0.004 inches. In still another configuration, the distal end radii can be about 0.002 inches or greater. Increasing the radii of the distal end of support member **340** to about 0.004 inches, for instance, can decrease the amount of force required to overcome a bend in locator assembly **200** over those devices having a distal end radii of about 0.002 inches. This is because a gap formed between the interior diameter of support member **340** and the locator assembly **200** is larger for the 0.004 inch radii than for the 0.002 inch radii.

In addition to the above, with the distal end having a radii greater than 0.002 inches, such as but not limited to 0.004 inches, there is a decrease in the possibility that the support member **340** cuts or otherwise damages the locator assembly **200** during positioning of the distal end of the apparatus **100** and subsequent deployment of the closure element **500**. Further, a radii greater than 0.002 inches, such as but not limited to 0.004 inches, may not increase the forces used to split an introducer sheath and may not elongate the introducer sheath during positioning and deploying of the closure element **500**.

With reference to FIGS. **1**A and **1**B, carrier assembly **120** may also include a portion of housing **380**. For instance, the carrier assembly **120** can optionally include the top half **380***c* of housing **380**, illustrated in FIG. **1**A, and the bottom half **380***d* is shown in FIG. **1**B. It will be understood, however, that housing **380** may be separate from the carrier assembly **120**, while retaining and/or receiving all or a portion of the carrier assembly **120**.

Housing **380** may be formed as an elongate member with a longitudinal axis, a periphery and may include proximal end region **380***a* and distal end region **380***b*. Thereby, when apparatus **100** is assembled, tubular body **210** of locator assembly **200** may be at least partially disposed within, and slidable relative to, tube set **305** such that distal end region **210***b* of tubular body **210** extends beyond distal end regions **310***b*, **320***b*, **330***b*, and/or **340***b*. Tubular body **210**, carrier member **310**, pusher member **320**, cover member **330**, and, if provided, support member **340** may be at least partially disposed within, and slidable relative to, housing **380**. Proximal end region **210***a* of tubular body **210** and proximal end regions **310***a*, **320***a*, **330***a*, and/or **340***a* of tube set **305** can be at least partially disposed within, and slidable relative to, housing **380**. Distal end regions **210***b*, **310***b*, **320***b*, **330***b*, and **340***b* may extend from distal end region **380***b* of housing **380** such that common longitudinal axis **350** of tube set **305** may be substantially axially aligned with longitudinal axis **386** of housing **380**. When configured to slidably retain respective proximal end regions **210***a*, **310***a*, **320***a*, **330***a*, and **340***a*, housing **380** supports tube set **305** and can have one or more handles **391**, **392** to facilitate use of apparatus **100**. Handles **391**, **392** may extend, optionally substantially radially, from the outer periphery of housing **380** and can be provided as illustrated or in any manner known in the art.

To facilitate deployment of the closure element **500**, the apparatus **100** can include a triggering system **400**, shown in FIG. **2**, which cooperates with a portion the locator assembly **200**. For instance, a portion of locator assembly **200** and a portion of triggering system **400** may cooperate and be accessible externally to housing **380**, as shown in FIGS. **1**A and **1**B. As shown in FIGS. **1**A, **1**B, **4**-**7**, triggering system **400** of apparatus **100** may be disposed substantially within housing **380**. Triggering system **400** may be configured to control the relative axial movement and/or positioning of distal end regions **310***b*, **320***b*, **330***b*, and **340***b* and/or locator assembly distal end region **210***b*. Axial motion of one or more of carrier member **310**, pusher member **320**, cover member **330**, and support member **340** and/or tubular body **210** may be attained, for example, by applying an axial force to triggering extension **405**.

Triggering system **400** may include a set of block members including carrier block **410**, pusher block **420**, cover block **430**, and support block **440**, each of which may be formed integrally with or securely attached to its respective member of carrier assembly **120**. The block members may be adapted to selectably couple and decouple carrier member **310**, pusher member **320**, cover member **330**, and support member **340** relative to one another in order to provide axial movement of those components in a predetermined manner intended to deliver closure element **500** in the manner described herein. For example, when carrier assembly **120** reaches a first predetermined distal position, support member **340** may be decoupled from carrier member **310**, pusher member **320**, and cover member **330**, and may be thereafter substantially inhibited from further axial movement. Thereby, carrier member **310**, pusher member **320**, and cover member **330** may be directed distally as support member **340** remains substantially stationary. Subsequently, carrier member **310** and cover member **330** can be decoupled from pusher member **320** and thereby inhibited from further axial movement. Pusher member **320** may be directed distally as support member **340**, carrier member **310**, and cover member **330** remain substantially stationary, as described more fully herein.

Carrier block **410** may be disposed on proximal end region **310***a* of carrier member **310** and may include trigger extension **405**, which extends through a slot in housing **380** to the exterior of housing **380**, accessible by a user. This carrier block **410**, as shown in FIG. **3**A, may include a pair of grooves **413***a*-*b* formed on a peripheral surface of carrier block **410**. Grooves **413***a*-*b* may be adapted to receive and retain a pair of tabs **445***a*-*b* formed on a pair of legs **444***a*-*b* extending distally from support block **440**, thereby selectably coupling support block **440** to carrier block **410**. Carrier block **410**, as illustrated in FIG. **1**A, may also include a pair of distal tabs **416***a*-*b* extending from the distal end of carrier block **410**, and adapted to engage a pair of slots **423***a*-*b* formed on the proximal end of pusher block **420**.

As shown in FIGS. **1**A and **3**A, carrier block **410** may also include a pair of arms **414***a*-*b* extending in the proximal direction from the proximal end of carrier block **410**, each of arm **414***a*-*b* having an outward directed tab **415***a*-*b* at its proximal end. Tabs **415***a*-*b* may be adapted to selectably engage a pair of slots **387***a*-*b* (FIG. **1**B) formed on the interior surface of housing **380** near its proximal end and, when so engaged, to fix the axial position of carrier block **410** and, with it, carrier assembly **120** relative to housing **380**. Tabs **415***a*-*b* may be disengaged from slots **387***a*-*b* FIG. **1**B) in housing **380** when locator assembly block **280** is moved axially in the distal direction in the following manner. As locator assembly block **280** is advanced distally, the interior surfaces of the ramps **283***a*-*b* on locator assembly block legs **282***a*-*b* engage the exterior surfaces of tabs **415***a*-*b* and cause carrier block arms **414***a*-b to flex inward, releasing tabs **415***a*-*b* from the slots **387***a*-*b* in the housing, thereby freeing carrier block **410** and carrier assembly **120** to move axially. Thus, axial movement of carrier block **410** within apparatus **100** is inhibited until locator assembly block **280** is advanced to transition locator assembly **200** to the expanded condition, simultaneously releasing tabs **415***a*-*b* on carrier block **410**.

Pusher block **420** may be disposed on proximal end region **320***a* of pusher member **320**. As described above, pusher block **420** may include a pair of slots **423***a*-*b* formed on its proximal end, and adapted to selectably engage distal tabs **416***a*-*b* extending from the distal end of carrier block **410**. Pusher block **420** may also include a pair of grooves **424***a*-*b* formed on its peripheral surface, the grooves **424***a*-*b* being adapted to engage a pair of tabs **435***a*-*b* formed on a pair of forks **434***a*-*b* extending from the proximal side of cover block **430** to selectably couple cover block **430** to pusher block **420**.

Cover block **430** may be disposed on proximal end region **330***a* of cover member **330**. As described above, cover block

430 may include a pair of forks 434*a-b* extending from the proximal end of the cover block 430, each of forks 434*a-b* having an inward directed tab 435*a-b* adapted to engage grooves 424*a-b* on the peripheral surface of pusher block 420 to selectably couple cover block 430 to pusher block 420.

Support block 440 may be disposed on proximal end region 340*a* of support member 340. As described above, support block 440 may include a pair of legs 444*a-b* extending from the distal end of the support block 440, each of legs 444*a-b* having an inward directed tab 445*a-b* adapted to engage grooves 413*a-b* formed on the surface of carrier block 410 to selectably couple support block 440 to carrier block 410.

Carrier block 410, pusher block 420, cover block 430, and support block 440 are shown in FIGS. 2, 3A, 4-5 in their fully coupled state, with support block 440 coupled to carrier block 410, pusher block 420 coupled to carrier block 410, and cover block 430 coupled to pusher block 420. In this arrangement, carrier assembly 120 comprises a coaxial set of tubes as shown in FIG. 8, with support member 340 slidably retained substantially within carrier member 310, which is in turn slidably retained substantially within pusher member 320, which is in turn slidably retained substantially within cover member 330.

Triggering system 400 of apparatus 100 may include an energy storing element that is used in the final stage of closure element 500 delivery processes. The energy storing element, such as, but not limited to, a spring, such as pusher spring 425 shown in FIGS. 1A, 1B, 6 and 7, may be substantially retained in a spring cavity 417 formed in carrier block 410 and coaxially surrounds a proximal end region 310*a* of carrier member 310. Pusher spring 425 is capable of expanding and contracting, storing potential energy as it is contracted and releasing energy as it expands. In its fully expanded state, the pusher spring 425 has a length that is greater than the length of spring cavity 417. The cross-sectional dimension of pusher spring 425 may be such that it backs up against and contacts the proximal end of pusher block 420. Thus, when pusher spring 425 is in place between carrier block 410 and pusher block 420, pusher spring 425 is capable of imparting a force biasing carrier block 410 away from pusher block 420.

Prior to delivery of closure element 500, the distal end of carrier block 410 is in physical contact with the proximal end of pusher block 420. In this pre-delivery condition, pusher spring 425 is in a contracted state and is maintained fully within spring cavity 417. A catch member 418 serves the function of maintaining the carrier block 410 and pusher block 420 in the pre-delivery condition against the spring force of pusher spring 425, the force of which would otherwise force apart carrier block 410 from pusher block 420. Catch member 418 may be a U-shaped piece of metal, plastic, or other rigid material that engages first groove 419*a* formed on the surface of carrier block 410 and second groove 419*b* formed on the surface of pusher block 420. With reference to FIGS. 1A and 1B, pusher block 420 includes hole 426 extending through a portion thereof, with one end of hole 426 opening into groove 419*b*. Hole 426 is adapted to receive trip pin 427. During the closure element deployment process, trip pin 427 is advanced through hole 426, where it encounters catch member 418 retained in the groove 419*b*. Further advancement of trip pin 427 causes catch member 418 to become disengaged from groove 419*b*, thereby releasing the force of pusher spring 425.

The operation of the triggering system 400 of the apparatus 100 is illustrated in FIGS. 2-8 with the closure element 500 disposed substantially within the apparatus 100. As shown in FIGS. 2-3B, apparatus 100 has an initial position in which locator assembly block 280 is extended proximally and triggering system 400 is in its most proximal position. Accordingly, the locator assembly 200 is in its unexpanded state, as shown in FIG. 3B. At a point in time that the distal end region 210*b* of the locator assembly 200 has been positioned as desired (for example, within the blood vessel), locator assembly block 280 is depressed distally, as shown in FIG. 4, thereby transitioning locator assembly 200 to the expanded state, as shown in FIG. 3C, and, simultaneously, releasing triggering system 400 from the initial position (in the manner described above) such that triggering system 400 can be advanced distally within the housing 380.

Triggering system 400 can then be advanced distally within housing 380, thereby advancing tube set 305 into position adjacent the blood vessel. At a first predetermined position, shown in FIGS. 4 and 5, support block 440 encounters a support stop (not shown) on the interior surface of housing bottom half 380*d* that inhibits support block 440 from advancing further distally. As a result, an application of additional distal force to triggering system 400 causes support block 440 to decouple from carrier block 410. More specifically, tabs 445*a-b* on legs 444*a-b* of support block 440 disengage from grooves 413*a-b* on carrier block 410. Thus, support block 440 remains in the position shown in FIGS. 4 and 5, while carrier block 410 is able to advance further distally upon application of force to triggering system 400.

Turning to FIGS. 6-8, as the triggering system 400 is advanced further distally; cover block 430 engages a cover stop on the interior surface near the distal end region 380*b* of housing 380, thereby inhibiting additional distal advancement of cover block 430. In addition, trigger extension 405 engages handle 391 of the apparatus, thereby inhibiting additional distal advancement of carrier block 410.

Closure element 500 is next deployed by releasing pusher spring 425, which causes pusher block 420 (and, thus, pusher member 320 (FIG. 1A)) to advance distally, deploying closure element 500 in the manner described above. As previously described, pusher spring 425 is released by disengaging catch member 418 from groove 419*b* on pusher block 420, thereby releasing pusher spring 425 to force pusher block 420 and, thus, pusher member 320 distally relative to carrier block 410. This action causes pusher member 320 to deploy closure element 500 from within tubeset 305. The catch member 418 is disengaged from groove 419*b* by applying a force to a trigger 401, which, in the deployment position, is aligned with trip pin 427 retained in pusher block 420. A trigger spring 402 biases trigger 401 outward relative to housing 380, with a portion of the trigger 401 extending through a hole 130 (FIG. 1B) in housing 380. A user applies an inward directed force to trigger 401 to counteract the biasing force of trigger spring 402 and force trigger 401 against the trip pin 427.

With reference to FIGS. 1A and 6, in addition to deploying closure element 500, the distal advancement of pusher block 420 also causes locator release system 490 to activate, thereby transitioning locator assembly 200 from the expanded state to the unexpanded state. As pusher block 420 advances distally to deploy closure element 500 in the manner described above, pusher block 420 also engages engagement member 493 of locator release system 490 and advances locator release rod 491 distally. This action causes release tab spacer block 492 to disengage from release tabs 284*a-b* on locator assembly block 280 (see FIG. 1), thereby releasing locator assembly block 280, which returns to its proximal position, causing locator assembly 200 to return to

the unexpanded state. An indicator window (not shown) may be formed in housing **380** to give a visual indication that tab spacer block **492** has disengaged and that locator assembly **200** has returned to the unexpanded state. The deployment of closure element **500** and locator release actions occur nearly simultaneously.

Referring now to FIGS. **9-13**, an alternative embodiment of the apparatus is shown in accordance with the present invention. The apparatus of the alternative embodiment is functionally similar to that of the device previously described above and shown in FIGS. **1-8** in most respects, wherein certain features will not be described in relation to the alternative embodiment wherein those components function in the manner as described above and are hereby incorporated into the alternative embodiment described below.

Generally, the apparatus **1000** illustrated in FIGS. **9-13** can accommodate for variations in the size of the physician's hand and grip by selectively reducing the distance between the device's handle portion and a portion of the triggering system usable to deploy the closure element and/or move a carrier assembly. Advancement of a locator assembly for locating the blood vessel wall prior to deploying the closure element can at least partially advance a portion of the triggering system of the apparatus including a trigger extension graspable by a physician or clinician. This partial movement reduces the gap or throw between the trigger extension and the handle portion. In this manner, a physician or clinician does not need to stretch uncomfortably to position a thumb or finger on the trigger extension, grasping the handle portion, and maintaining the device in the desired orientation relative to the tissue and/or the puncture site.

As shown in FIG. **9**, the apparatus **1000** can include a housing **1380** comprising housing halves **1380***c* and **1380***d* (FIG. **10**). These housing halves **1380***c* and **1380***d* (FIG. **10**), either individually or collectively, can form one or more handle, hand grip, or finger portions which a physician or clinician can grip or hold to manipulate the apparatus **1000**. As illustrated, the apparatus **1000** can include finger grip **1391** and finger grip **1392** at a distal end and finger grips **1394***a* and **1394***b* on the proximal end of housing **1380** to facilitate use of locator assembly **1110**, and specifically plunger **1280**.

In addition, the apparatus **1000** can include handle, hand grip, or finger portion disposed on the distal end of housing **1380** configured to be engaged by a user when advancing housing **1380** to deploy closure element **500** (FIG. **1**A). This handle or handle portion or hand grip portion can include a shaped grasping portion **1600** and an elongate grasping portion **1392** spaced apart from the shaped grasping portion **1600**. Each of the portions **1392** and **1600** may be contoured to be received by a user's hand. For instance, the grasping portion **1600** can provide a stable base upon which the physician or clinician can move the device or apparatus as the closure element is positioned and deployed. This grasping portion **1600** can have a shaped portion **1602** having a curved configuration that can receive at least a thumb or finger of the physician as the physician or clinician holds the apparatus **1000**. The curved configuration or profile allows the physician to grasp the handle or handle grip portion while resting their hand, wrist or forearm upon a patient during the procedure, such as deployment of the closure element, thereby providing stability during use of the device.

It will be understood that although reference is made to one particular configuration of the handle, hand grip, or finger portions, one skilled in the art will appreciate and can identify various other configurations of handle portion that can perform the function of providing a stable base for manipulation of the apparatus **1000**. For instance, and not by way of limitation, the handle portion can be planar rather than curved. Further, the handle portion can include one or more finger receiving holes. In addition, the handle portion can include a material to provide cushioning or comfort to the physician and/or clinician. For example, flexible, yielding, or elastic materials can be formed or applied to all or a portion of the handle portion.

Referring now to FIGS. **9** and **10**, apparatus **1000** can be provided as one or more integrated components and/or discrete components. For instance, and not by way of limitation, apparatus **1000** may include locator assembly **1110** and carrier assembly **1120**. For purposes of illustration, locator assembly **1110** and carrier assembly **1120** are shown in FIG. **10** as comprising substantially separate assemblies. As desired, however, locator assembly **1110** and carrier assembly **1120** may each be provided, in whole or in part, as one or more integrated assemblies. Portions of locator assembly **110** and/or carrier assembly **120** can also be used as part of apparatus **1000**. Alternatively, modified versions of locator assembly **110** and/or carrier assembly **120** can be used.

Locator assembly **1110** may be constructed in the manner previously described above, including a flexible or semi-rigid tubular body (such as an elongate rail) with a longitudinal axis. The tubular body can have a proximal end region and a distal end region and can include a predetermined length and a predetermined outer cross-section, both of which can be of any suitable dimension. The distal end region of the locator assembly may include a substantially rounded, soft, and/or flexible distal end or tip to facilitate atraumatic advancement and/or retraction of the distal end region into a blood vessel or other opening in tissue. As desired, a pigtail (not shown) may be provided on the distal end to further aid atraumatic advancement of the distal end region. The distal end region of locator assembly **1110** may be selectably controllable between an unexpanded state and an expanded state.

As shown in FIG. **10**, apparatus **1000** can include carrier assembly **1120** which is functionally equivalent to carrier assembly **120** (FIG. **1**A) described above and will not be described in detail with regard to the alternative embodiment. As with carrier assembly **120**, carrier assembly **1120** may be coupled with, and slidable relative to, locator assembly **1110**. Carrier assembly **1120** may be configured to receive and retain the closure element **500** (shown in FIGS. **14**A-**14**G), which can be disposed substantially within carrier assembly **1120**. Carrier assembly **1120** can function to position closure element **500** substantially adjacent to an opening to be closed, and to deploy closure element **500**.

Referring now to FIGS. **10** and **11**, locator assembly **1110** of the alternative embodiment will be described in greater detail. As with the previous locator assembly, a control member **1250**, such as a rod, wire, or other elongate member, can be moveably disposed within a lumen (not shown) formed by tubular body **1210** and extend substantially between the proximal end region and the distal end region. Control member **1250** can have a proximal end region **1250***a* that may be coupled with a control block **1260**, and a distal end region that may be coupled with the distal end region of locator assembly **1110**, expansion members **1230**, and/or movable end regions of substantially flexible members, such as flexible members **232** (FIG. **3**B). Control block **1260** may be constructed in a tubular shape and formed of a metal or rigid plastic, and is adapted to be retained in control block

cavity **1265** (FIG. **11**A) formed on the internal surface of the housing bottom half **1380***d*, to thereby maintain control block **1260** in a substantially fixed position relative to housing half **1380***d* and so housing **1380**. The locator assembly **1110** can selectively transition distal end region **1210***b*, expansion members **1230**, and/or the substantially flexible members between the unexpanded and expanded states by moving tubular body **1210** axially relative to control member **1250**. Additionally, as shown in FIG. **11**A, apertures **1383** may be placed adjacent to an in communication with detents **1385**, wherein in use as described below, tabs **415***a* and **415***b* (FIG. **1**A) engage the detents **1385** during use. Apertures **1383** are configured to receive the tip of a medical device, such as a tip of a dilator from a sheath assembly, wherein the tip of the dilator can be utilized to disengage the tabs **415***a* and **415***b* (FIG. **1**A) from the detents **1385** thereby releasing the locked position of the device. This enables a user to move the trigger assembly **1400** (FIG. **10**) proximally (toward the user) after the clip has been deployed in the event that the device becomes stuck within the patient, thereby providing a safety release mechanism. It shall be appreciated that the apertures **1383** may be replaced by other features such recessed buttons that become exposed with the engagement of the tabs with the detents or alternatively a specific tool may be provided with the device.

With reference to FIGS. **10** and **11**B, to facilitate movement of carrier assembly **1120** to reduce the distance between a trigger extension **1405** and the distal end of housing **1380**, the functionality of locator assembly block **280** (FIG. **1**A) can be provided through the combination of a plunger **1280**, a tubular body block **1270**, and a spring retainer **1290**. In addition to providing the functionality of locator assembly block **280**, including but not limited to, controlling movement of expansion members **1230**, plunger **1280**, tubular body block **1270**, and spring retainer **1290** aid with moving trigger extension **1405** toward the distal end of housing **1380**.

With reference to FIG. **11**B, plunger **1280** can include two spaced apart legs **1282***a-b* separated by a plunger member **1284** to form a slot **1281** therebetween. The legs **1282***a-b* are spaced apart sufficiently to accommodate or receive a portion of tubular body block **1270** and/or spring retainer **1290** therebetween. Each of the legs **1282***a-b* can have a stepped configuration, such as shown in FIG. **11**D. Plunger **1280** may be slidably received and retained within grooves formed in the proximal end of housing **1380**, with the proximal end of plunger **1280** extending from the proximal end of housing **1380**.

Plunger **1280** may be constructed of metal, plastic, or other rigid material. The proximal end of plunger **1280** may have a slot **1281** formed therein. Slot **1281** may have a size sufficient to accommodate control block **1260** and control block cavity **1265**, and to allow plunger **1280** to travel axially relative to housing **1380**. As mentioned, the distal end of plunger **1280** has a pair of distally extending legs **1282***a-b* with optional ramps **1283***a-b* on respective inward facing surfaces. In addition, formed in each leg **1282***a-b* is a recess **1285** within which moves a protrusion **1286** having a dent **1288** that can interlock with at least one of tubular body block **1270** or spring retainer **1290** as plunger **1280** is moved distally.

With reference to FIGS. **11**B and **11**E, tubular body block **1270** may be formed integrally with or attached securely to tubular body **1210**. The tubular body block **1270** can include a pair of extending legs **1272***a-b*, with each of legs **1272***a-b* having a ramp portion **1273***a-b* on its inward facing surface. Ramp portions **1273***a-b* can cooperatively engage tabs, not shown but similar to tabs **415***a-b* (FIG. **1**A), of carrier block **1410** (FIG. **12**). In an initial state, the tabs **415***a-b* (FIG. **1**A) can be engaged in slots **1387***a*-**1387***b* (FIG. **11**A) formed in housing halve **1380***d* to hold triggering system **1400** (FIG. **10**) in a fixed axial relationship with housing **1380**.

Extending between legs **1272***a-b* is an intermediate member **1274** that can include a pair of upwardly extending extension **1276***a-b* and a tab **1278**, shown in dotted lines in FIG. **11**B. Extensions **1276***a-b* are received within the space between legs **1282***a-b* of plunger **1280**. Stated another way, tubular body block **1270** can be held in a fixed axial relationship with respect to plunger **1280** through the engagement of legs **1282***a-b* and legs **1272***a-b*. The tab **1278** can be adapted to cooperate with spring retainer **1290** and optionally lock with a portion of spring retainer **1290** as plunger **1280** moves distally, as will be described in more detail hereinafter.

Extending from intermediate member **1274** in the same direction as legs **1272***a-b* is a tubular portion **1279** that slidably cooperates with spring retainer **1290** and receives tubular body **1210** within a lumen. Further, tubular portion **1279** can cooperate with a locator assembly spring **1289** (FIG. **10**) which biases tubular body block **1270** and/or spring retainer **1290** relative to housing **1380**.

As shown in FIGS. **11**B and **11**F, spring retainer **1290** has a wall portion **1291** with a recess **1292** that can receive tubular portion **1279** of tubular body block **1270**. The wall portion **1291** defines a channel **1294** within which can be received locator assembly spring **1289** (FIG. **10**). For instance, locator assembly spring **1289** (FIG. **10**) can extend from wall portion **1291** to locator assembly spring stop **1381** (FIG. **11**A) to bias movement of spring retainer **1290**, tubular body block **1270**, and so locator assembly **1110**.

Spring retainer **1290** can further include arms **1296***a-b*. Arms **1296***a-b* can include a movable portion **1297***a-b* that can flex or move to receive tab **1278** of tubular body block **1270**. For instance, tab **1278** can include curved surfaces that cooperate and receive a portion of movable portion **1297***a-b* as tubular body block **1270** moves relative to spring retainer **1290**. Alternatively, tab **1278** can be positioned within a space **1299** between wall portion **1291** and movable portion **1297***a-b* before manipulation or operation of apparatus **1000**. It will be understood that other portions of arms **1296***a-b* can flex or move, whether or not movable portions **1297***a-b* move.

In addition to arms **1296***a-b*, spring retainer **1290** can include release tabs **1298***a-b*. These release tabs **1298***a-b* can function in a similar manner to tabs **284***a-b* (FIG. **1**A). For instance, tabs **1298***a-b* can cooperate with a locator release system **1490** in a manner substantially similar to the embodiments described above. For example, release tabs **1298***a-b* can engage release cavity **1495** on housing **1380**, and can be held from releasing by release tab spacer block **1492**.

Generally, plunger **1280**, tubular body block **1270**, and spring retainer **1290** can be formed of metal, plastic, or other material, whether or not rigid, substantially rigid, or flexible. As such, plunger **1280**, tubular body block **1270**, and spring retainer **1290** can be formed from medical grade synthetic materials or materials that can be sterilized or otherwise cleaned.

Turning now to FIGS. **12** and **13**, illustrated are the operational positions of the apparatus **1000** in (i) an initial state with the expansion members **1230** (FIG. **9**) in an unexpanded condition and (ii) a state with the expansion members **1230** (FIG. **9**) in an expanded condition.

With reference to FIG. **12**, in the initial state plunger **1280** extends from the distal end of housing **1380**, expansion

members **1230** are in an unexpanded condition, and locator assembly spring **1289**, which can be located coaxially with tubular body block **1270**, may be located between spring retainer **1290** and the proximal side of locator assembly spring stop **1381** formed on the inner surface of housing bottom half **1380***d*. In this initial state locator assembly spring **1289** is held in a biased state. Optionally, a portion of carrier assembly **1120** (FIG. **10**) can be associated with legs **1282***a-b* of plunger **1280** and contact carrier a portion of carrier assembly **1120** (FIG. **10**).

Once a user presses on plunger **1280** to expand expansion members **1230**, that is moving plunger **1280** toward expansion members **1230**, tubular body block **1270** and tubular body **1210** are advanced distally by distal advancement of plunger **1280**. Upon advancement, and with reference to FIGS. **1**A and **10-12**, ramp members **1273***a-b* press tabs **415***a-b*, which are hidden by plunger **1280** in FIG. **12**, releasing carrier block **1410** to slide axially in housing **1380**, and release tabs **1298***a-b* engage in retaining grooves **1387***a-b* in cooperation with locator release system **1490**, which is functionally equivalent to locator release system **490** described above, thereby fixing spring retainer **1290** and tubular body block **1270** axially with respect to housing **1380**, and fixing expansion members **1230** of locator assembly **1110** in an expanded state. Also during advancement, tab **1278** of tubular body block **1270** advances between arms **1296***a-b* of spring retainer **1290**, extending the arms outwardly until tab **1278** advances past the ends of arms **1296***a-b*, causing arms **1296***a-b* to extend behind tab **1278**, thereby coupling spring retainer **1290** and tubular body block **1270**, and fixing tubular body block axially prior to activation of locator release system **1490**. Also, once advanced the plunger **1280** is locked into a distal position by legs **1272***a* and **1272***b*.

Further axial movement of plunger **1280** can allow engagement of distal end **1283***b* of leg **1282***b* and carrier block **1410**, thereby moving carrier block **1410** distally along with carrier assembly **1120**, as illustrated in FIG. **13**. This additional movement of carrier assembly **1120** also moves trigger extension **1405**, shortening the distance required to fully engage the carrier assembly **1120**. Combining the deployment of locator assembly **1110** and the partial advancement of carrier assembly **1120** in a single step, allows for a reduction in travel of the trigger block and trigger extension **1405**. This reduction of travel allows for a greater variation in user strength as well as the physical size of a user's hand to fit better with device **1000** as illustrated.

Once locator assembly **1110** is deployed, carrier assembly **1120** can be advanced distally by exerting force on trigger extension **1405**, and can be fixed in the distal position in the manner described above with reference to other embodiments above. After the locator has been deployed and the carrier assembly initially advanced as shown in FIG. **13**, device **1000** functions in the manner described above with regard to other embodiments of the present invention and thus will not be described in detail with regard to this embodiment.

In some embodiments, the tubular body block and the release block may be integrally formed. When the tubular body block and the release block are integrally formed, axial movement of the locator assembly block can force outward movement of tabs holding the tubular body block to the locator assembly block, allowing the integrally formed tubular body block and release block to slide distally with respect to the locator assembly block, and cause the release tabs to load the locator release system to release as discussed above.

Referring now to FIGS. **14**A-**14**G illustrating embodiments of a closure element that can be used as part of or with the apparatus **100**. The closure element, generally identified with reference numeral **500**, may have a generally annular-shaped body defining a channel and one or more barbs and/or tines for receiving and engaging the blood vessel wall and/or the tissue around the opening. Although the closure element has a natural shape and size, the closure element can be deformed into other shapes and sizes, as desired, and can be configured to return to the natural shape and size when released. For example, closure element **500** can have a natural, planar configuration with opposing tines and a natural cross-section. The closure element can be formed from any suitable material, including any biodegradable material, any shape memory material, such as alloys of nickel-titanium, or any combination thereof. Additionally, it is contemplated that the closure element may be coated with a beneficial agent or be constructed as a composite, wherein one component of the composite would be a beneficial agent. As desired, the closure element may further include radiopaque markers (not shown) or may be wholly or partially formed from a radiopaque material to facilitate observation of the closure element using fluoroscopy or other imaging systems. Exemplary embodiments of a closure element are disclosed in U.S. Pat. Nos. 6,197,042, 6,623,510, 6,461,364, 6,391,048, and 6,623,510. The disclosures of these references and any others cited therein are expressly incorporated herein by reference.

As described previously, and with reference to FIG. **15**A, closure element **500** can be disposed within the carrier assembly and adjacent to the distal end of pusher tube **320**. As shown in FIG. **15**A, for example, the reduced closure element **500** may be slidably received over distally-increasing cross-section **318***b* of distal end region **310***b* of carrier member **310** and disposed about periphery **312** of carrier member **310** adjacent to space **360**. Since reduced cross-section **530** of reduced closure element **500** is less than cross-section **318***b* of distally-increasing cross-section **318***b*, reduced closure element **500** must be temporarily radially deformed to be received over distal end region **310***b*. Also, as reduced closure element **500'** (FIG. **14**C) is received over distal end region **310***b*, opposing tines **520** of reduced closure element **500'** (FIG. **14**C) engage distal end region **310***b*. Reduced closure element **500'** (FIG. **14**C) thereby forms substantially tubular closure element **500"**, illustrated in FIG. **14**G, with the ends of the barbs and/or tines extending towards the distal end of the apparatus **100**.

The apparatuses of the present invention may be configured to be utilized with a sheath, wherein the sheath is inserted or otherwise positioned into an opening in a body comprising a lumen. The sheath generally comprises a substantially flexible or semi-rigid tubular member having a proximal end region and a distal end region and includes a predetermined length and a predetermined cross-section, both of which can be of any suitable dimension. The sheath forms a lumen that extends along a longitudinal axis or the sheath and substantially between the proximal and distal end regions. The lumen can have any suitable internal cross-section and is suitable for receiving one or more devices (not shown), such as a catheter, a guide wire, or the like. The lumen is configured to slidably receive the tubular body of the locator assembly and/or the tube set of the carrier assembly of the devices in accordance with the present invention.

Since the internal cross-section of the sheath may be less than or substantially equal to the predetermined cross-section of the cover member, the sheath may be configured

to radially expand, such as by stretching, to receive the tube set. Alternatively, or in addition, the sheath may be advantageously configured to split as the tube set is received by, and advances within the lumen of the sheath, thereby permitting the apparatuses to access the blood vessel wall. To facilitate the splitting, the sheath can include one or more splits, such as longitudinal splits, each split being provided in a manner known in the art. Each split is configured to split the sheath in accordance with a predetermined pattern, such as in a spiral pattern. It will be appreciated that, when the internal cross-section of the sheath is greater than the predetermined cross-section of the cover member, it may not be necessary for the sheath to be configured to radially expand and/or split. In addition to, or as an alternative to, the apparatus may include a cutting means that initiates a tear line or split in the sheath when the sheath is engaged with the distal end of the apparatus.

The sheath may be advanced over a guide wire or other rail (not shown), which has been positioned through the opening and into the blood vessel using conventional procedures such as those described above. Preferably, the blood vessel is a peripheral blood vessel, such as a femoral or carotid artery, although other body lumens may be accessed using the sheath as will be appreciated by those skilled in the art. The opening, and consequently the sheath, may be oriented with respect to the blood vessel such as to facilitate the introduction of devices through the lumen of the sheath and into the blood vessel with minimal risk of damage to the blood vessel. One or more devices (not shown), such as a catheter, a guide wire, or the like, may be inserted through the sheath and advanced to a preselected location within the patient's body. For example, the devices may be used to perform a therapeutic or diagnostic procedure, such as angioplasty, atherectomy, stent implantation, and the like, within the patents vasculature.

FIGS. **15**A-K illustrate one exemplary manner to deploy closure element **500** by apparatuses according to the present invention. For purposes of continuity, reference numbers to the first discussed embodiment are used, but it will be evident that other embodiments discussed above may be used in a similar fashion.

A sheath **640** may be inserted or otherwise positioned through a patient's skin **650** and tissue **630** and within the blood vessel **600** or other body lumen via the opening **610**. This provides access to the blood vessel **600** through the blood vessel wall **620** for performance of a therapeutic or diagnostic procedure.

After the procedure is completed, the devices associated with the therapeutic or diagnostic procedure are removed from sheath **640**, and apparatus **100** can be prepared to be received by lumen **644** of the sheath. Being in the unexpanded state, the distal end region **210***b* of tubular body **210** of the locator assembly **200** an be slidably received by the lumen and atraumatically advanced distally into the blood vessel **600**, as illustrated in FIG. **15**B. Once the distal end region **210***b* extends into blood vessel **600**, distal end region **210***b* can transition from the unexpanded state to the expanded state by activating the switching system of locator assembly **200**, and as illustrated in FIG. **15**C. As discussed with reference to the embodiments described in reference to FIGS. **9-13**, the carrier assembly may be partially advanced when the locator assembly is transitioned from the unexpanded to the expanded state by pressing the locator assembly block distally with respect to the housing.

Turning to FIG. **15**D, apparatus **100** and/or sheath **640** can then be retracted proximally until distal end region **210***b* is substantially adjacent to an outer surface **620***b* of blood vessel wall **620**. Distal end region **210***b* thereby draws blood vessel wall **620** taut and maintains the proper position of apparatus **100** as blood vessel **600** pulsates. Since the expanded cross-section of distal end region **210***b* is greater than or substantially equal to the cross-section of opening **610** and/or the cross-section of lumen **644**, distal end region **210***b* remains in blood vessel **600** and engages inner surface **620***b* of blood vessel wall **620**. Distal end region **210***b* can frictionally engage inner surface **620***b* of blood vessel wall **620**, thereby securing apparatus **100** to blood vessel **600**. Sheath **640** can be retracted proximally such that distal end region **640***b* of sheath **640** is substantially withdrawn from blood vessel **600**, permitting apparatus **100** to access blood vessel wall **620**.

Once distal end region **210***b* of locator assembly **200** contacts inner surface **620***b* of blood vessel wall **620**, tube set **305** can then be advanced distally and received within lumen **644** of sheath **640**. In the manner described above, sheath **640** can radially expand and/or split in accordance with the predetermined pattern as tube set **305** advances because the internal cross-section of sheath **640** is less than or substantially equal to pre-determined cross-section **338***b* of cover member **330**. Being coupled, carrier member **310**, pusher member **320**, cover member **330**, and support member **340** each advance distally and approach the first predetermined position, as illustrated in FIG. **15**F. As discussed with reference to the embodiments described in reference to FIGS. **9-13**, a stable base can be provided by handle portion **1600** having an enlarged, curved configuration that can receive at least a thumb or finger of the physician. The enlarged, curved handle portion **1600** can griped by the physician while the physician's hand is rested upon a patient during the procedure and provide stability during use of the device. Additionally, the combined deployment of locator assembly **1110** and the partial advancement of carrier assembly **1120** in a single step allows for a reduction in travel of trigger extension **1405**. Thus, a user does not need to reach uncomfortably far from handle portion **1602** to trigger extension **1405** to fully advance carrier assembly **1120** and the tube set coupled to the carrier assembly.

Upon reaching the first predetermined position, tube set **305** is disposed substantially adjacent to outer surface **620***a* of blood vessel wall **620** adjacent to opening **610** such that the blood vessel wall adjacent to opening **610** is disposed substantially between expanded distal region **210***b* of locator assembly **200** and tube set **305**. Support member **340** decouples from carrier member **310** and pusher member **320** in the manner described above when tube set **305** is in the first predetermined position. The cover member **330** and pusher member **320** are advanced. After advancement the cover member **330** is decoupled from the carrier member **310** and pusher member **320**. Thereby, cover member **330** and support member **340** may be inhibited from further axial movement and remain substantially stationary as carrier member **310** and pusher member **320** each remain coupled and axially slidable.

As shown in FIG. **15**G, cover member **330** and support member **340** remain substantially stationary while carrier member **310** and pusher member **320** continue distally and approach the second predetermined position. As carrier member **310** and pusher member **320** distally advance toward the second predetermined position, annular cavity **370** moves distally relative to substantially-stationary cover member **330** such that distal end region **330***b* of cover member **330** no longer encloses annular cavity **370**. Thereby, closure element **500** is not completely enclosed by

annular cavity **370** formed by distal end regions **310***b*, **320***b*, and **330***b* of carrier member **310**, pusher member **320**, and cover member **330**.

Although not completely enclosed by annular cavity **370**, substantially tubular closure element **500** is advantageously retained on outer periphery **312***b* of carrier member **310** by distal end region **330***b* of cover member **330** as illustrated in FIG. **15**G. For example, by retaining substantially tubular closure element **500** between distal end region **330***b* of cover member **330** and distal end region **310***b* carrier member **310**, apparatus **100** may be configured to provide better tissue penetration. The timing between the deployment of substantially tubular closure element **500** by tube set **305** and the retraction and transition to the unexpanded state by locator assembly **200** likewise is facilitated because substantially tubular closure element **500** is retained between distal end region **330***b* and distal end region **310***b*. Further, carrier member **310** and cover member **330** operate to maintain substantially tubular closure element **500** in the tubular configuration.

When tube set **305** is in the second predetermined position, carrier member **310** decouples from pusher member **320** in the manner described in detail above. Therefore, carrier member **310**, cover member **330**, and support member **340** may be inhibited from further axial movement and remain substantially stationary, whereas, pusher member **320** remains axially slidable. As pusher member **320** continues distally, distal end region **320***b* of pusher member **320** contacts substantially tubular closure element **500** and displaces substantially tubular closure element **500** from space **360** as shown in FIG. **15**H. Since space **360** is substantially radially exposed, pusher member **320** directs substantially tubular closure element **500** over the distally-increasing cross-section of distal end region **310***b* of substantially-stationary carrier member **310** such that the cross-section of substantially tubular closure element **500** begins to radially expand, preferably in a substantially uniform manner. As substantially tubular closure element **500** traverses the distally-increasing cross-section of distal end region **310***b*, the cross-section of substantially tubular closure element **500** radially expands beyond natural cross-section of closure element **500**, as shown in FIGS. **14**A-G.

Upon being directed over the distally-increasing cross-section of the distal end region by pusher member **320**, substantially tubular closure element **500** is distally deployed as illustrated in FIG. **15**I. When substantially tubular closure element **500** is deployed, tines **520** can pierce and otherwise engage significant amount of blood vessel wall **620** and/or tissue **630** adjacent to opening **610**. For example, tines **520** can engage significant amount of blood vessel wall **620** and/or tissue **630** because cross-section **530** of substantially tubular closure element **500** is expanded beyond natural cross-section **530** of closure element **500** during deployment.

As the closure element is being deployed from the space, locator assembly **200** may begins to retract proximally and locator release system **490** can be activated to transition from the expanded state to the unexpanded state as substantially tubular closure element **500** is deployed. Distal end region **210***b* of locator assembly **200** may retract proximally and transition from the expanded state to the unexpanded state substantially simultaneously with the deployment of substantially tubular closure element **500**. As desired, distal end region **210***b* may be configured to draw blood vessel wall **620** and/or tissue **630** adjacent to opening **610** proximally and into the channel defined by substantially tubular closure element **500**. Tines **520** of substantially tubular closure element **500** thereby can pierce and otherwise engage blood vessel wall **620** and/or tissue **630**.

Turning to FIG. **15**J, substantially tubular closure element **500**, once deployed, begins to transition from the tubular configuration, returning to the natural, planar configuration with opposing tines **520** and a natural cross-section of closure element **500**. Preferably, substantially tubular closure element **500** substantially uniformly transitions from the tubular configuration to the natural, planar configuration. Rotating axially inwardly to from opposing tines **520** of the closure element **500**, tines **520** draw the tissue into the channel as substantially tubular closure **500** element forms closure element **500**. Also, the tissue is drawn substantially closed and/or sealed as the cross-section of substantially tubular closure element **500** contracts to return to the natural cross-section.

It will be appreciated that the closure element may be constructed of other materials, that it may comprise alternative shapes, and that it may adopt alternative methods of operation such that the closure element achieves closure of openings in blood vessel walls or other body tissue. In an additional non-limiting example, the closure element is constructed of materials that use a magnetic force to couple a pair of securing elements in order to close an opening in the lumen wall or tissue. In this alternative embodiment, the closure element may be of a unitary or multi-component construction having a first securing element positionable at a first position adjacent the opening, and a second securing element positionable at a second position adjacent the opening. The first and second securing elements are provided having a magnetic force biasing the first and second securing elements together, thereby closing the opening, or they are provided having a magnetic force biasing both the first and second securing elements toward a third securing element positioned in a manner to cause closure of the opening. The magnetic closure element may be provided without tines, provided the magnetic force coupling the closure elements is sufficient to close the opening. Alternatively, the closure element may be provided with a combination of the magnetic securing elements and tines to provide a combination of coupling forces. Those skilled in the art will recognize that other and further materials, methods, and combinations may be utilized to construct the closure element to achieve the objectives described and implied herein.

The invention is susceptible to various modifications and alternative means, and specific examples thereof have been shown by way of example in the drawings and are herein described in detail. It should be understood, however, that the invention is not to be limited to the particular devices or methods disclosed, but to the contrary, the invention is to cover all modifications, equivalents, and alternatives falling within the spirit and scope of the claims.

We claim:

1. An apparatus for delivering a closure element to an opening formed in a wall of a body lumen, the apparatus comprising:

a locator assembly configured to be used to position the apparatus in relation to the wall of the body lumen, the locator assembly comprising a distal end that is configured to transition between an unexpanded state and an expanded state; and

a closure element disposed proximal the distal end of the locator assembly and configured to be slidably advanced toward the distal end of the locator assembly,

wherein, when the locator assembly transitions from the unexpanded state to the expanded state the closure

element simultaneously advances distally towards the distal end of the locator assembly.

2. The apparatus as recited in claim **1**, wherein when the locator assembly transitions from the expanded state to the unexpanded state the closure element is simultaneously advanced past the distal end of the locator assembly.

3. The apparatus as recited in claim **1**, further comprising a triggering system configured to control movement of the closure element.

4. The apparatus as recited in claim **3**, further comprising a carrier member configured to support the closure element and a pusher member configured to advance the closure element off the carrier member.

5. The apparatus as recited in claim **1**, wherein said locator assembly further comprises a control member coupled to at least one expansion member and a tubular member surround the control member.

6. The apparatus as recited in claim **1**, wherein said locator assembly comprises a spring configured to bias the distal end to the unexpanded state.

7. The apparatus as recited in claim **6**, wherein the locator assembly comprises a spring retainer receiving a portion of said spring and a locator actuator slidably cooperating with the spring retainer.

8. An apparatus for placement into an opening formed in a wall of a body lumen, the apparatus comprising:

a housing comprising an elongate body and a handle portion formed at a distal end and extending generally transversely from the elongate body, the handle portion comprising a shaped grasping portion and an elongate grasping portion;

a locator assembly configured to be used to position the apparatus in relation to the wall of the body lumen, the locator assembly comprising a distal end disposed distal the distal end of the handle portion, the distal end of the locator assembly being configured to transition between an unexpanded state and an expanded state; and

a closure element disposed proximal the distal end of the locator assembly and configured to be slidably advanced toward the distal end of the locator assembly,

wherein, when the locator assembly transitions from the unexpanded state to the expanded state the closure element simultaneously advances distally towards the distal end of the locator assembly.

9. The apparatus of claim **8**, wherein the locator assembly comprises a locator actuator configured to slide in relation to a proximal end of the housing, wherein distal movement of the locator actuator transitions the locator assembly from the unexpanded state to the expanded state.

10. The apparatus of claim **9**, further comprising a trigger assembly operatively cooperating with the locator actuator, the trigger assembly comprising a trigger extension extending transversely from the housing.

11. The apparatus of claim **10**, wherein distal movement of said locator actuator simultaneously transitions said distal end of said locator assembly to the expanded state, advances the closure element toward the distal end of the locator assembly, and advances the trigger extension distally toward a distally positioned finger grip of the housing in a single step.

12. The apparatus as recited in claim **10**, wherein a trigger extension of the trigger assembly is coupled to and extends from a carrier assembly comprising a carrier tube that supports the closure element, the trigger extension being configured to advance the carrier assembly prior to deployment of the closure element.

13. The apparatus as recited in claim **8**, wherein the shaped grasping portion is spaced apart from the elongate grasping portion.

14. The apparatus as recited in claim **8**, wherein the distal end of the housing further comprises at least one distal handle portion extending from the housing in a direction substantially opposite to at least one of the shaped grasping portion or the elongate grasping portion.

15. The apparatus as recited in claim **8**, wherein the shaped grasping portion has a generally curved configuration with a recess adapted to receive at least one of a thumb or finger during use of the apparatus.

16. An apparatus for placement into an opening formed in a wall of a body lumen to deploy a closure element, the apparatus comprising:

a housing comprising a handle portion formed at a distal end and extending in a first direction;

a locator assembly configured to be used to position the apparatus in relation to the wall of the body lumen, a distal end of the locator assembly comprising one of more expansion members configured to be expanded substantially transversely to a longitudinal axis of the locator assembly when a distal end of the locator assembly transitions from an unexpanded state to an expanded state; and

a closure element disposed proximal the distal end of the locator assembly and configured to be slidably advanced toward the distal end of the locator assembly, the closure element being carried upon a carrier member and deployed from the carrier member,

wherein,

when the distal end of the locator assembly transitions from the unexpanded state to the expanded state the closure element simultaneously advances distally towards the distal end of the locator assembly, and

when the distal end of the locator assembly transitions from the expanded state to the unexpanded state the closure element simultaneously advances distally past the distal end of the locator assembly.

17. The apparatus as recited in claim **16**, wherein the distal end of the locator assembly comprises an expansion member that comprises a flexible member.

18. The apparatus as recited in claim **17**, wherein the locator assembly further comprises a control member coupled to the expansion member and a tubular body surrounding the control member.

19. The apparatus of claim **17**, wherein the carrier member supports the closure element in a substantially tubular configuration, the carrier member being part of a carrier assembly that further comprise a pusher member for distally deploying the closure element, and a cover member for retaining the closure element, wherein the carrier member, the pusher member, and the cover member are slidably coupled.

20. The apparatus of claim **19**, wherein the carrier member, the pusher member, and the cover member are provided as a plurality of nested, telescoping members with a common longitudinal axis.

* * * * *